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The Design and Construction of the Bassano Dam: Part I

By H. B. Muckleston*

SYNOPSIS—A part of the immense irrigation system of the Canadian Pacific Railway, southeast of Calgary, is a composite dam consisting of an earth embankment 7000 ft. long and 35 to zero ft. high, an Ambursen hollow reinforced-concrete dam, 750 ft. between abutments, 39 ft. high to the crest, which is divided into 24 openings each 27 ft. long, provided with Stoney gates 11 ft. high; and a reinforced-concrete headwork, at right angles to the dam proper, having five 20-ft. openings, closed by Stoney gates 14 ft. high. The dam is designed to pass 100,000 sec.-ft. of water with 14 ft. on the crest. The dam rests on a stratum of clay, beneath which is sand containing water under slight pressure. The floor of the dam is pierced by weep holes and iron pipes extend from the bridge level of the dam to and through the clay. A floating timber apron is placed below the dam. Construction was carried on in extremely cold weather. Salamanders beneath tarpaulins supported on horses were used to thaw frozen ground to a depth of 6 ft. for excavation. Concrete work was not stopped until the temperature fell below —15° F. The water and gravel were heated and all forms were double boarded. The sluice gates are protected against frost by housing and by an electric-heating system.

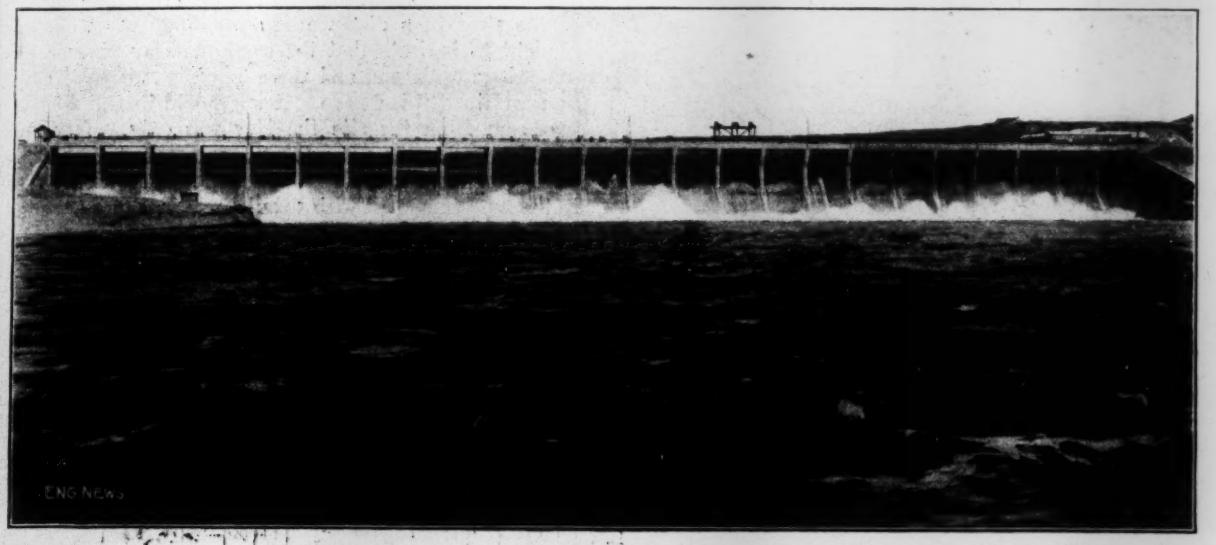
The Canadian Pacific Railway Co. has recently completed, as a part of its great irrigation project, one of the most notable overfall dams now in existence.

The dam, which is located on the Bow River, about one hundred miles southeast of Calgary, is noteworthy not only because of its dimensions and the composite character of its construction, but also because of the unusually great depth of water which it is designed to pass over its crest during floods.

The Irrigation Project

The map, Fig. 1, gives a general idea of the country covered by the irrigation system and shows, besides the main canals and ditches, the location of the principal watershed and drainage lines. It will be noted that much of the greater part of the irrigated area is on the North or Red Deer River slope of the divide, and that consequently only a fraction of the water diverted will ever return to the Bow River. The total irrigable area commanded by the system is, in round figures, some 440,000 acres. The canal system, to reclaim this large area, involved moving some 21,000,000 cu.yd. of excavation in all classes; over 100,000 cu.yd. of concrete were built into the structures on the main, branch and secondary canals; and 9,500,000 ft. b.m. of timber were used in flumes, bridges and the structures on the smaller ditches and laterals. The total mileage of canals and ditches is in excess of 3000. It will be seen, therefore, that the project is exceeded in magnitude by few outside India and by none on this Continent.

The first surveys for this project were made by the writer in 1906. They were confined to securing general information and to making rough estimates of the area which could be irrigated and the cost of the diversion



Spillway or Overfall Portion of Bassano Dam, Canadian Pacific Irrigation Project

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works, based on several assumptions as to crest elevation of the proposed dam. These surveys showed that the project was feasible from an engineering point of view

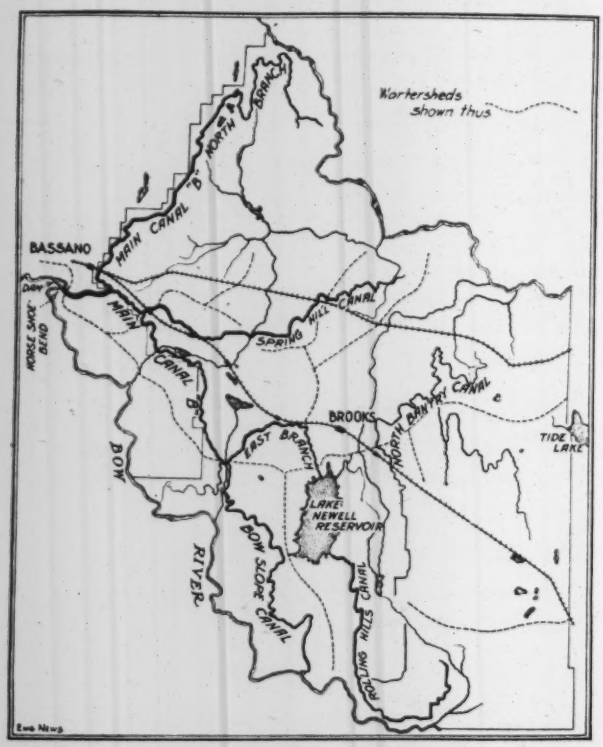
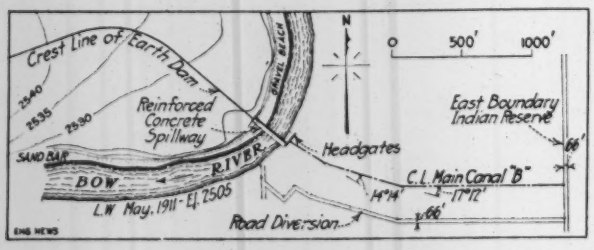


FIG. 1. MAP OF CANADIAN PACIFIC IRRIGATION SYSTEM, EAST OF CALGARY, ALBERTA

and that it could be built within the limit which had been set as to cost. Further surveys were made in 1909, and the crest elevation finally fixed after several alternative preliminary locations of the larger canals and a closer examination of the areas which they commanded.

DESIGN OF THE DAM

It will be noted from the map, Fig. 1, that at the point of diversion the main divide between the rivers is very close to the Bow; only 600 ft. away, in fact. At this point begins a wide valley known as Crawling Valley, which cuts square across the country from the Bow River to the Red Deer. Toward the Red Deer River it falls about 65 ft. in 13,000 ft. in the upper region, while to-



ward the Bow the fall is 90 ft. in 600 ft. The average depth of this valley is about 70 ft., and its width about 600 ft. As the summit of the pass thus found was but 90 ft. above the river it offered a splendid opportunity to divert water for irrigation, provided it proved feasible to construct a dam of some height across the river valley.

Fig. 2 is a general site plan showing the location of the dam. The left bank of the river, which forms the outside of the horseshoe, is a high clay cut bank or cliff, varying from 150 to 200 ft. in height, with practically no beach whatever at the bottom except in very extreme low water. The right bank or inside of the horseshoe is a gravel beach gradually sloping up to a silt bank at high-water mark. The tongue of land inside the horseshoe slopes gradually up from the toe of the shoe to the general bench elevation of the adjoining country. It shows visible evidence that it has been built by the river, as the stream gradually cut its way down and widened the sweep of the curve.

Fig. 3 is a general profile showing the result of the borings put down to determine the character of the foundations. Under the clay at a varying depth is a stratum of unknown thickness composed of a coarse water-bearing sand, not quite free running but weakly cemented. Most of the boreholes were stopped when the sand stratum was reached, but a few were carried deeper in an effort to reach the bottom of the sand, though without any success. It was found that the water in the sand was under a slight pressure, which was measured and found to correspond roughly with the fall in the surface of the river in a distance of about 3000 ft. This was thought to indicate that the overlying clay pinched out somewhere upstream, and three boreholes were put down to ascertain if this was so. It was found that at 2600 ft. upstream from the site the clay was only 2 ft. thick. The theory that the water found access from the river was confirmed by subsequent observations on the pressure head in the sand compared with parallel readings of a gage rod in the river. The similarity of the curve was unmistak-

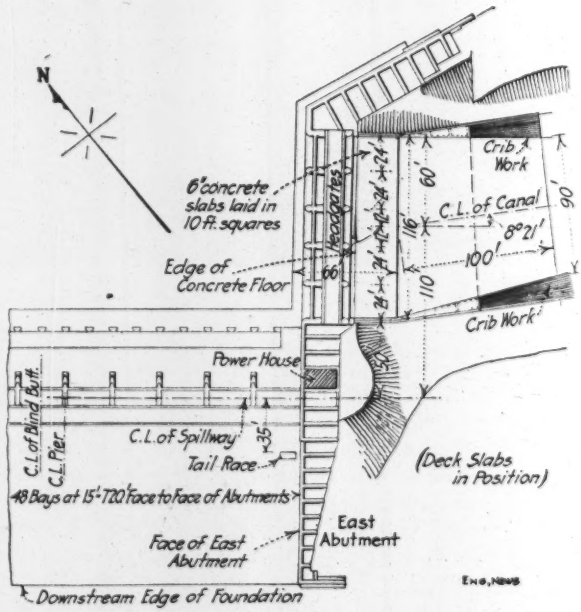


FIG. 2. GENERAL PLAN OF BASSANO DAM AND DETAIL PLAN OF HEADGATES

able, though there was a lag in phase amounting to 30 hr., for which no satisfactory explanation has yet been offered.

The strata under the tongue of land inside the horse-

shoe are similar to those under the river except that the gravel layer is very much thicker and is overlaid by a stratum of silt left behind by the river as it gradually cut its way down.

When the dam was first proposed, very little was known of the hydrology of the river, the few discharge records that were available being unsatisfactory in that they gave little or no indication as to the maximum floods which might be expected. The only refuge, therefore, was a careful series of gagings and a search for flood marks. From these gagings and what flood marks could be found it was estimated that a flood of 100,000 sec.-ft. was possible, and the dam was designed to pass this quantity with 14 ft. of water on the crest. This corresponds to a runoff of 12.5 cu.ft. per sec. per sq.mi. from a drainage area of 8000 sq.mi.

The range in discharge of the river is very wide, varying as it does from a minimum in winter of about 1200 sec.-ft. to the calculated flood discharge above given. Ordinary spring and summer freshets seldom rise much above 30,000 sec.-ft., though considerably larger floods of short duration are not infrequent.

The time factor in flood rises in the Bow is important, variations of 20,000 sec.-ft. in discharge in 10 or 12 hr. being by no means unusual and often coming without much warning. Owing to the narrow valley and steep slope of the river bed the pondage area above the dam is comparatively small, not over 3500 acres, during low stages. It was therefore very necessary that means be provided for rapid working of any crest sluices, and also that the earth dam be given an unusual freeboard above ordinary pool level.

The dam as finally built consists of two or rather three parts: (1) an earth embankment 7000 ft. long, built on the right bank inside the horseshoe; (2) a reinforced-concrete spillway section, built in the river bed; and (3) a reinforced-concrete canal headwork built at right angles to the spillway and integral with it.

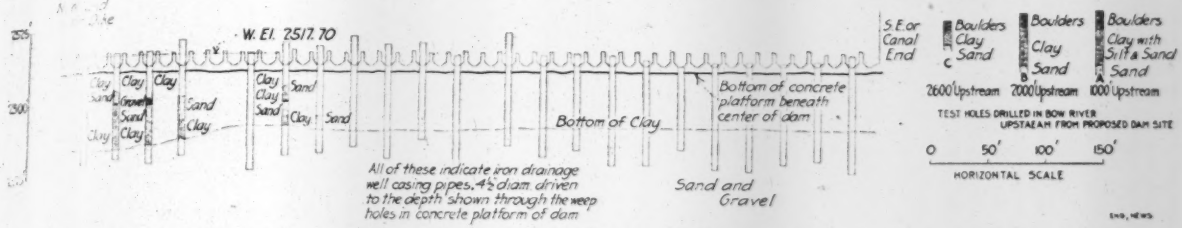

W. El. 2517.70
Clay
Sand
Gravel
Bottom of Clay
Bottom of concrete platform beneath center of dam
All of these indicate iron drainage well casing pipes, 4½ diam. driven to the depth shown through the weep holes in concrete platform of dam
Sand and Gravel
S.E. or Canal End
Boulders Clay Sand
Boulders Clay Sand
Boulders Clay with Silt & Sand Sand
C
B
A
2600' Upstream
2000' Upstream
1000' Upstream
TEST HOLES DRILLED IN BOW RIVER UPSTREAM FROM PROPOSED DAM SITE
0 50' 100' 150'
HORIZONTAL SCALE

FIG. 3. MATERIAL PENETRATED BY DRAIN PIPES 9 FT. UPSTREAM FROM CENTER LINE OF BASSANO DAM

The embankment varies in height from 35 ft. to zero. It was designed to have a top width of 24 ft., with 1 to 1 wet slope and 3 to 1 dry slope, and to have a freeboard at ordinary high stages of 9 ft. The thickness as built is much in excess of what the above dimensions would indicate, as a large surplus of material from the canal cut was wasted over the back of the earth dam, resulting in a top width varying from 40 to 100 ft. The wet slope is protected from erosion by a concrete paving surmounted by a curved parapet wall to prevent any wave wash from going over.

The spillway is 720 ft. between abutments. It is of the typical Ambursen section (Fig. 4). The crest is divided into 24 openings, each 27 ft. long, closed when required by Stoney sluices 11 ft. high. The headworks consist of 5 openings, each 20 ft. wide, closed by Stoney sluices 14 ft. in height.

The general design of the composite structure was determined by the Railway Company's engineers after a careful study of all the conditions above outlined. Having decided that the cellular type of reinforced-concrete construction would best meet requirements for the spillway and headworks, the detailed design of these parts was placed in the hands of the Ambursen Company, who also undertook the superintendence of construction. All drawings were approved by the Railway Company's engineers before becoming effective. Both design and construction were carried out under very complete specifications approved by both the Railway Company and the Ambursen Company.

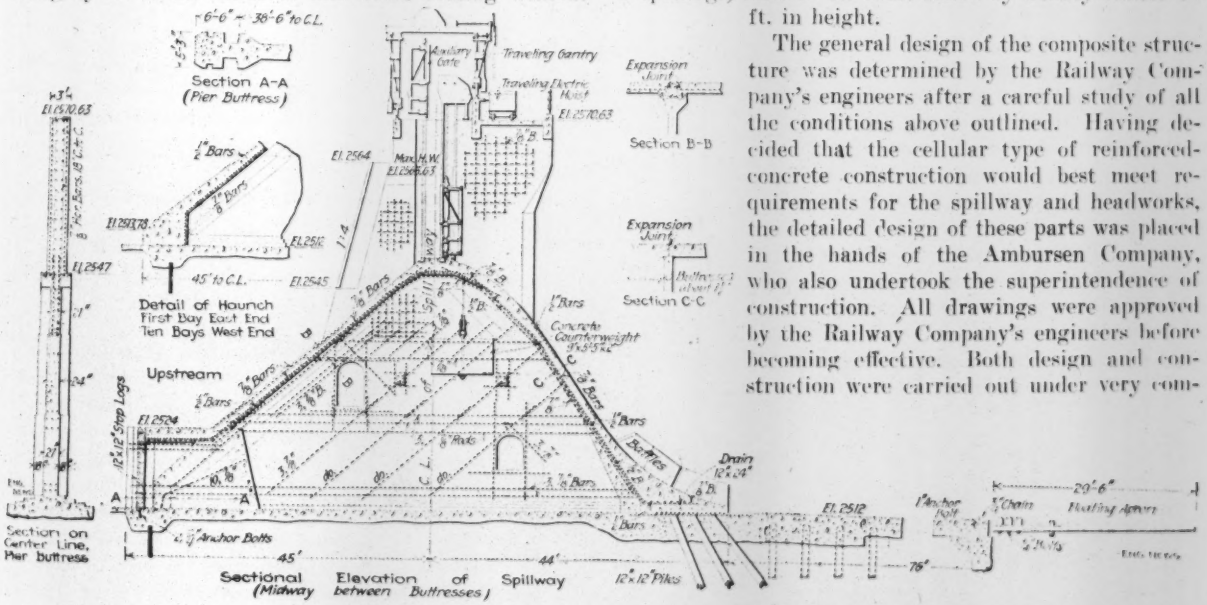
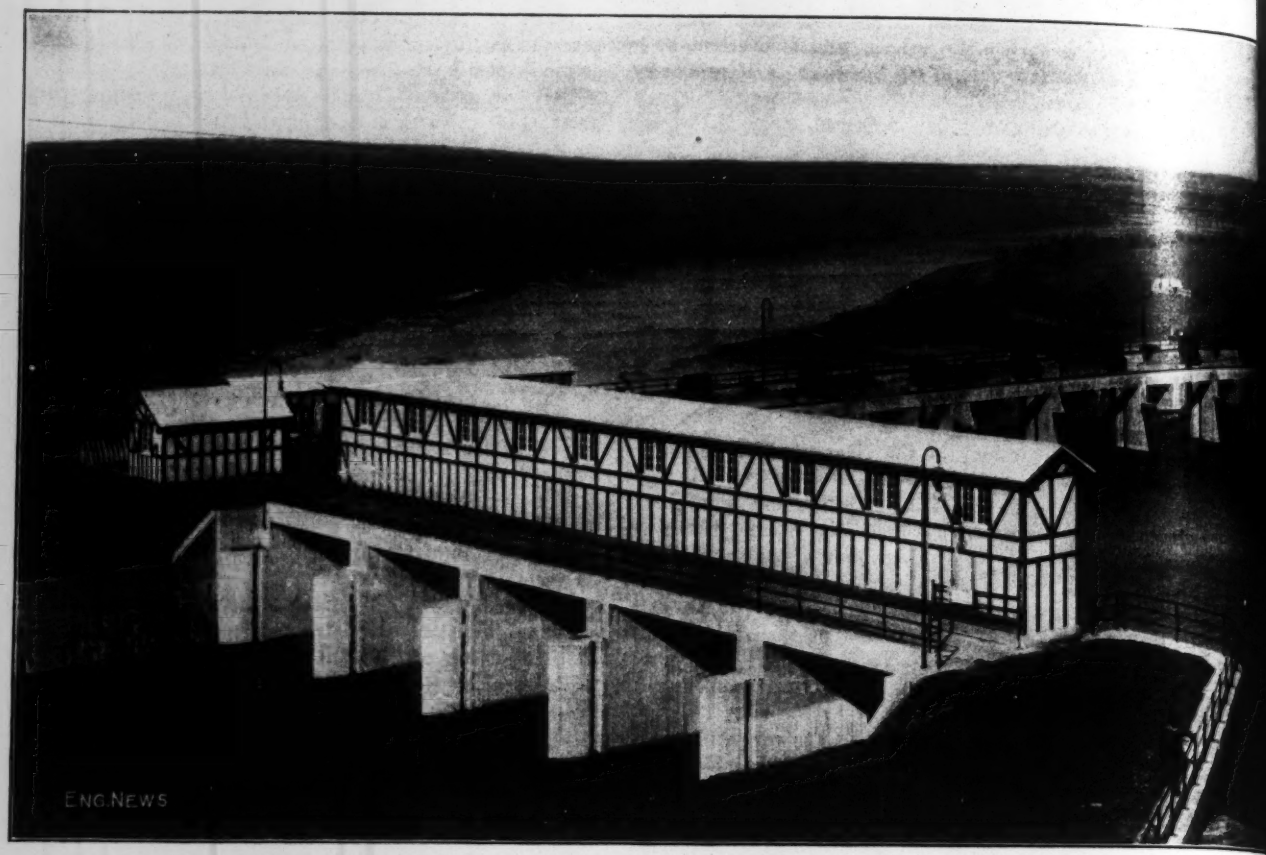


FIG. 4. SECTIONS OF BASSANO DAM

The maximum allowable unit stresses used in the design of all parts of the structure were as follows:



Bearing power of foundations	2.5 tons per sq.ft.
Buttresses in compression	300 lb. per sq.in.
Buttresses in direct shear	100 lb. per sq.in.
Footings, compression in bending	500 lb. per sq.in.
Footings, tension in bending	0 lb. per sq.in.
Footings, shear in bending	75 lb. per sq.in.
Deck apron, compression in bending	600 lb. per sq.in.
Deck apron, tension in bending	0 lb. per sq.in.
Deck apron, shear in bending	60 lb. per sq.in.
Steel reinforcement, tension	14,000 lb. per sq.in.
Structural steel, tension	16,000 lb. per sq.in.

All the above maximum unit stresses are considered as limiting values based on loading of structures due to the greatest expected flood head, namely, 14 ft. above crest and no allowance made for effect of backwater.

For all members of the structure the steel is so designed as to take the entire tensile stress without aid from the concrete. For all buttresses, walls, tumbling hearth, etc., steel is inserted in such quantities as will assure against excessive cracking due to temperature stresses and vibration.

All cement was tested on the works and had to conform to the specifications of the Canadian Society of Civil Engineers.

One of the first problems to be solved was the spacing of the interior buttresses. This is a problem which depends on judgment and experience rather than on mathematics for its solution. After a number of preliminary designs had been worked up and studied, it was decided to space these buttresses 15 ft. c. to c. and to carry the alternate buttresses up to form piers for the support of the sluice gates.

The floor of the structure is pierced by numerous weep holes to relieve any possible upward pressure from water which might pass the sheet piling and be trapped under the floor.

As mentioned above, the water contained in the sand stratum is under pressure, and strong presumptive evidence existed that this pressure was equivalent to the head of a point about 3000 ft. upstream. If the presumption were true the upward pressure on the clay might, under certain circumstances, be more than the superincumbent weight, and accordingly steps were taken to relieve it. This was accomplished by twenty-four 5½-in. iron-cased wells bored through the clay and extended above the interior bridge level.

Stoney Gates—For the sluice gates, a great many different types were considered, the choice finally narrowing down to Taintor sectors as against the Stoney free-rolling pattern. The latter were finally decided on, for, while the choice involved a considerable increase in cost, it was felt that they would be better suited to the conditions and more certain in operation. The gates are handled from an overbridge and are counterweighted to 90% of their unimmersed weight. The overbridge is calculated for a loading equivalent to five tons on two pairs of wheels.

Floating Apron—In order to minimize the effects of any possible scour which may develop below the concrete apron, a floating timber apron has been provided (Fig. 4). This device has been found extremely effective in other situations in preventing scour in soft bottoms or, to put it more correctly, in transferring the scour to a point when it can do no harm. Since the floating apron is not closely built, it is not pressed down flat but assumes some mean position under the combined forces of its own tendency to float and the tendency of the current to force it down.

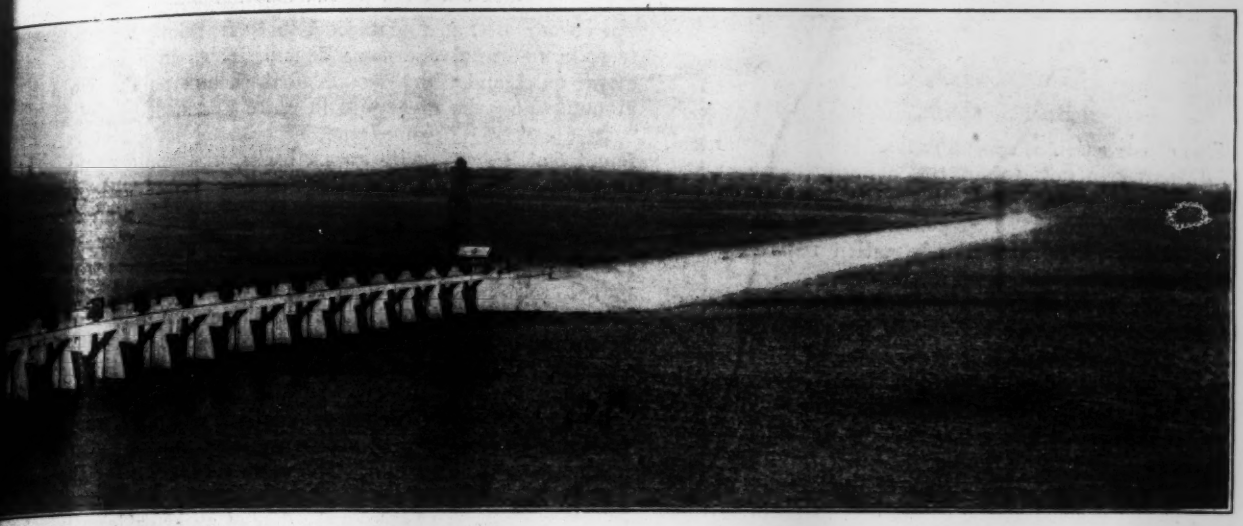


FIG. 6. HEADGATE STRUCTURE, SPILLWAY AND EARTH EMBANKMENT OF BASSANO DAM

PROTECTION OF SLUICE GATES AGAINST FROST BY HOUSING AND ELECTRIC HEATING—One of the problems in the design of the dam to which a great deal of study was given was the effect of the peculiar winter climate on the structure and its operation. One of the salient features of the irrigation project is the large interior reservoir lying south of Brooks—Lake Newell on the map (Fig. 1). It is intended to fill this reservoir during the winter months when the canals are not required for irrigation purposes. This involves very delicate control of the discharge of the canals in order to avoid trouble from ice jams and consequent possible breaching of the canal banks. It will be seen, therefore, that under no circumstances must the crest sluices ever be allowed to become inoperative through frost. To guard against this a very complete system of electric heating for the gates has been installed and special precautions in the way of housing have been taken to insure that all the canal head sluices and two of the crest sluices shall be free from ice at all times.

The effects of ice shove or expansion on the static stability of the dam were very carefully considered and allowed for. It was felt, however, that even so it would be wise to treat the cause rather than the effects, and steps are therefore taken to keep a trench open close above the piers.

Fig. 6 shows across both pages the entire dam and headgate structure at Bassano Dam. On the left is the headgate and stretching away to the far background on the back is the earth embankment.

The construction of the dam will be described in a later issue.

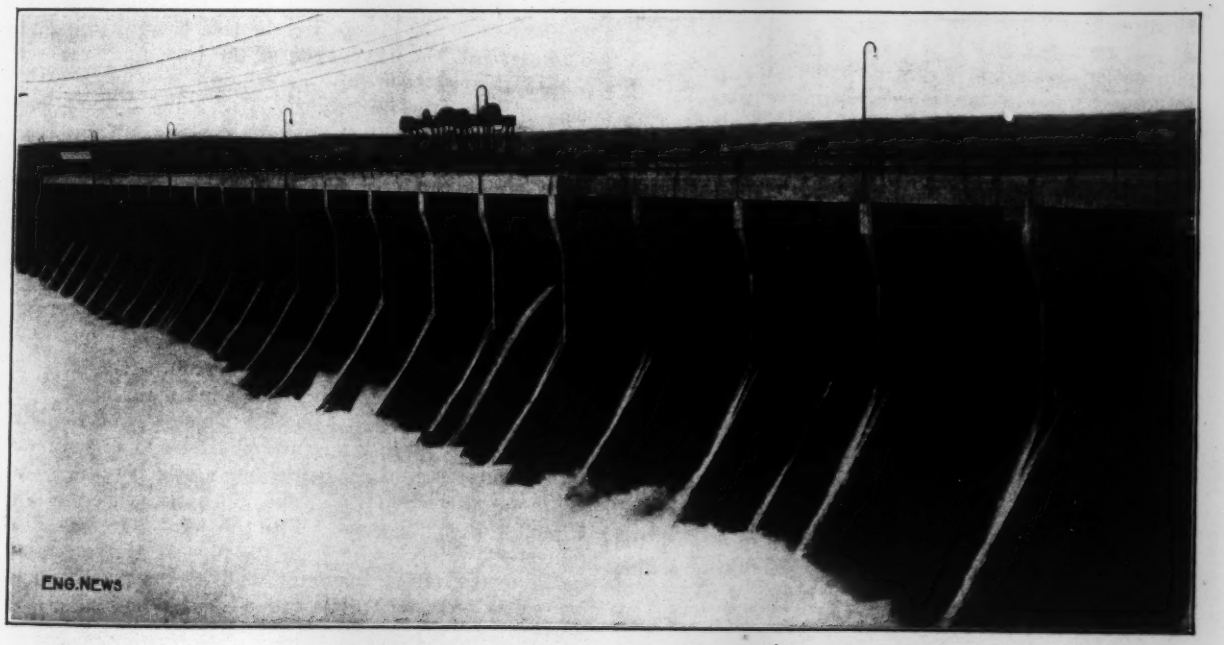


FIG. 7. BASSANO DAM, LOOKING UPSTREAM AFTER COMPLETION

Construction of a Small Sewerage System for Garfield, N. J.

By Russell S. Wise*

The construction of some 30 mi. of sewers for Garfield, N. J., partly in wet ground, the laying of house connections and other features of this work, including record keeping, seem worth putting on record in view of the comparatively little recent information regarding such work readily available to engineers.

Garfield, N. J., a borough in Bergen County, lies about 12 mi. west of New York City. It has an area of about 2.14 sq.mi. and a present population of over 12,000. Topographically, it is broken into three ridges, with the valley of the Passaic River on the west; the Saddle River Valley on the east and south and the flat land of Saddle River Township on the north.

In designing the sewer system of the borough of Garfield, it was deemed at the outset best to drain to three points on the Passaic River and to discharge a small system into the Saddle River. Four sewage-treatment plants were planned; three, each of a capacity of 1,000,000 gal. daily, were to be built on the easterly bank of the Passaic River, and the fourth, having a capacity of 400,000 gal. daily, was located on the north bank of the Saddle River. Those which were to be built upon the Passaic River were intended to be abandoned as soon as the auxiliary sewer to be constructed by the Passaic Valley Sewerage Commissioners was in readiness to receive the sewage of Garfield.

The sewerage system, as designed, covered all of the streets, opened and unopened, which were shown upon the official assessment map of the borough. The sewers have, however, been built only in the most populous sections of the borough. Up to July, 1914, about 30 mi. of main sewers have been constructed. Connections from the sewers to the curbs have, in all cases, been laid.

The system, which is now considered to be completed, has cost about $210,000. Of this sum, a bond issue of $145,000 was voted by the people to defray the cost of the main outlet sewers and disposal plants. The remainder of the cost was met by moneys raised from the sale of improvement certificates redeemable in one year, drawing interest first at 5% and afterwards changed to 6% when it was found difficult to dispose of these certificates at the lesser rate.

The contract was let to Martin & Miller, of Seneca Falls, N. Y., and the work begun July 31, 1911.

Trenching machines were used upon most of the sewers. The "Buckeye" machine did the most satisfactory work as a good deal of the trenching in the hilly sections of the borough was in clay and hardpan mixed with boulders and occasional layers of red shale. The machine tore most of this material, boulders and shale, without damage to itself. When blasting was necessary, the machine's elevating wheel was hoisted to the top of the trench, logs were chained and placed in position over the holes and the blast fired, all without injury to any portion of the machinery, and no loss of time in moving the machine occurred. In loamy or clayey soils this machine excavated from 500 to 700 lin.ft. of trench 6 to 8 ft. in depth per day of nine hours.

*Assistant Engineer with Wise & Watson, Passaic, N. J., in charge of construction of Garfield sewers.

In the central portion of the borough, ground water was encountered at a depth of 1 to 10 ft. below the surface, in fine sand and some distance down in a stiff clayey quicksand which resembled thick blue paint. No attempt to lay the sewer pipe in water was made.

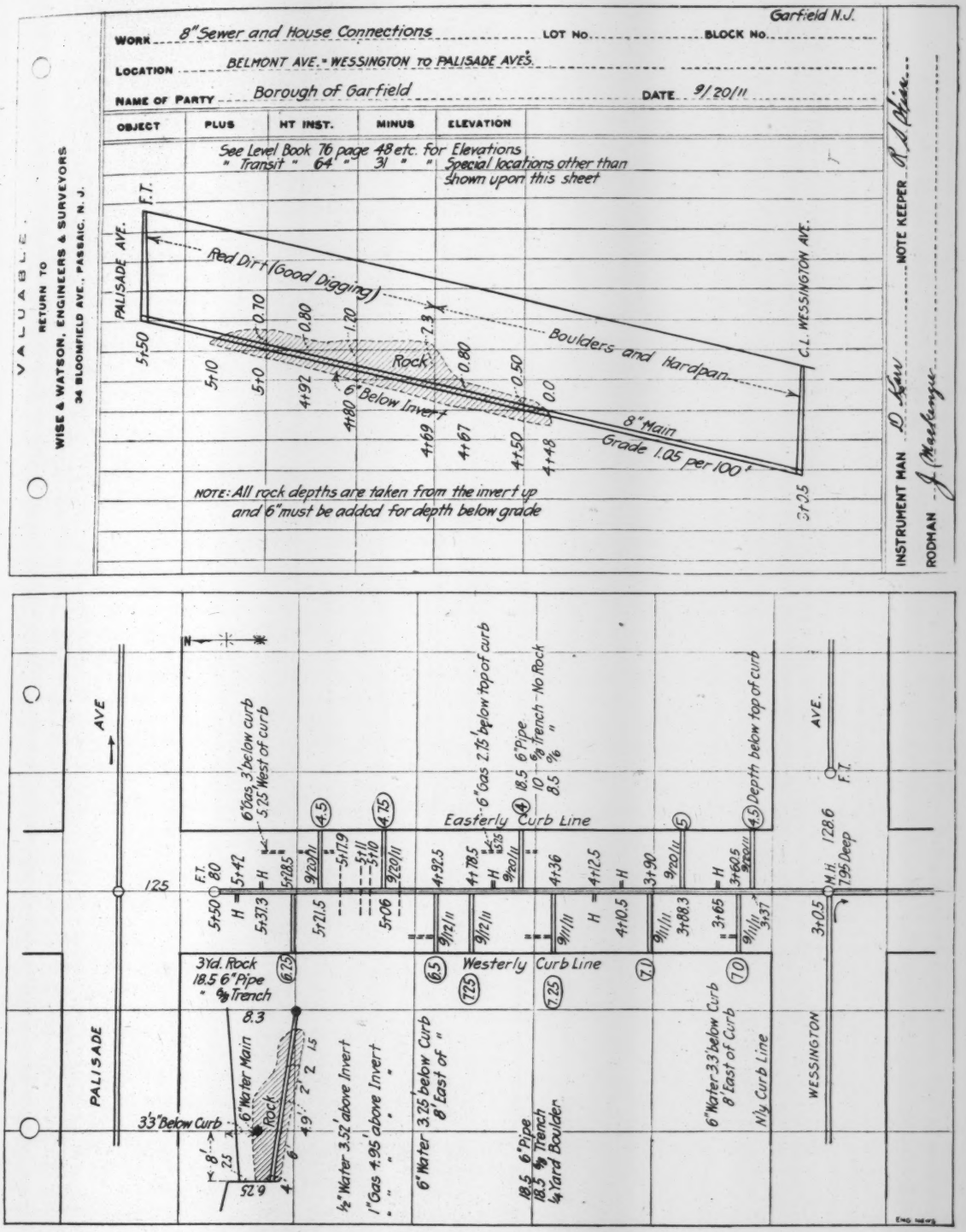
In excavating in quicksand, or quaking soils, it was found that laborers, with strong backs, who would stand very still, could skim off the soil in 3-in. layers without causing any appreciable flow of water and the bottom of the trench would be in excellent condition to place a foundation of gravel and sand; whereas, the laborers who moved around and used their feet in digging would soon bring about watery conditions. The trench would cave in and come up under the sheeting almost as fast as it was dug out and so cause trouble and expense in laying the pipes.

In all quicksand trenches, foundations of gravel, varying in depth from 6 to 18 in., depending upon the nature of the material, were laid. The extra excavation for the foundations was paid for by the cubic yard. The gravel foundations seemed to check the flow of water sufficiently to lay the pipe, and proved very satisfactory. In a few cases, where the gravel foundations did not fulfill the requirements, concrete was placed upon the gravel. This was done by excavating the trench 50 to 60 ft. in advance of the pipe and tamping a comparatively dry mixture of 1:3:5 concrete into the gravel. After leveling the concrete to within 1 in. of the grade of the outer bottom of the bell of the pipe, the concrete was allowed to set 24 hr. The pipes were then laid upon this foundation by raising the grade of the trench with the same mixture. After jointing, as described further on, the concrete was raised to the springing line of the pipe and in some cases was sloped from the springing line to the top of the pipe. The backfilling with dry material then proceeded, covering the pipe about 2 ft., and the balance of the trench was filled with the original material. So far the pipes seem to be in good line and grade.

In sheeting quicksand trenches, a strip of sheet iron about 6 in. wide and the length of the sheeting was nailed on one edge of the planks, the sheeting being driven with the sheet iron on the outside of the trench. The sheet iron overlapped every joint and the pressure of the earth outside forced the iron tightly against the sheeting and so made a very nearly water-tight sheeting. Where concrete foundations were placed and the sheeting directed to be left in, this proved to be very economical.

A special or cloth-wrapped joint was used in all wet trenches. This was made by tying a strip of cloth about 8 in. wide and 4 in. longer than the length of the circumference of the pipe. The cloth was torn from both ends about 2 in. wide and one-quarter the length of the cloth for tying around the bell end of the pipe. The pipe was then placed in the trench and after setting true to line and grade and calking the joint with tarred jute to fill three-quarters of the socket, which was of the deep and wide sort, a 1:1 mixture of sand and cement was tightly pressed into the joint and neatly beveled. The cloth was then drawn over the joint and rubbed on the outside with neat cement. With this joint there was little danger of water leaking into the pipe or of the cement being washed from the joint, and at the present time there has been very little ground water noticed in the sewers.

House connections, of 6-in. pipe, were run from the


Garfield N.J.
WORK 8" Sewer and House Connections LOT NO. BLOCK NO.
LOCATION BELMONT AVE. - WESSINGTON TO PALISADE AVES.
NAME OF PARTY Borough of Garfield DATE 9/20/11
OBJECT PLUS HT INST. MINUS ELEVATION
See Level Book 76 page 48 etc. for Elevations
" Transit " 64 " 31 " " Special locations other than shown upon this sheet
VALUABLE. RETURN TO WISE & WATSON, ENGINEERS & SURVEYORS 34 BLOOMFIELD AVE., PASSAIC, N. J.
INSTRUMENT MAN
NOTE KEEPER
RODMAN
F.T.
PALISADE AVE.
Red Dirt (Good Digging)
Boulders and Hardpan
Rock
6" Below Invert
8" Main
Grade 1.05 per 100'
C.L. WESSINGTON AVE.
NOTE: All rock depths are taken from the invert up and 6" must be added for depth below grade
Easterly Curb Line
Westerly Curb Line
6" Gas 3' below curb 5.25 West of curb
6" Gas 2.15' below top of curb
6" Pipe 18.5 % Trench - No Rock 10 % " 8.5 % "
Depth below top of curb
3 Yd. Rock 18.5 6" Pipe % Trench
6" Water Main
Rock
6" Water 3.25' below Curb 8' East of "
4" Water 3.52' above Invert
1" Gas 4.95' above Invert
18.5 6" Pipe 18.5 % Trench 4 Yard Boulder
6" Water 3.3' below Curb 8' East of Curb
N'ly Curb Line
PALISADE AVE.
WESSINGTON AVE.
33" Below Curb
M.H. 128.6 7.95 Deep

FINAL RECORD PLAN AND PROFILE OF ONE BLOCK OF THE SEWERAGE SYSTEM OF GARFIELD, N. J.

sewer to 1 ft. inside of the inner face of the curbs. As the work progressed, each property owner was consulted as to his wishes and the connection placed just where he wanted it. Hubs were placed in front of every 25-ft. lot in addition to those connections run to the curbs. Where there was much vacant property, connections were run to the curb at the rate of about five to the hundred feet of sewer.

Chimneys or standpipes were built on all sewers where the depth was 12 ft. or more below the established grade of the street. They were encircled with a 6-in. shell of concrete extending from a point 6 in. below the outer bottom of the pipe to the bends from which the house connections were run. Wherever it was practicable, in order to serve two opposite houses, the chimneys were topped off with Y's and the cost so divided, for under the

decisions of our courts, the costs of each house connection must be kept separate and assessed upon the property according to its actual cost. The cost of the main sewers is to be assessed in accordance with the usual rule.

The keeping of the records for the house connections was much more difficult than that of the main sewers, as many of them were laid months after the main sewers were laid. During construction of the sewers, the position of the house connections was determined and the station marked on the face of the curb, or fence if there was no curb, at right angles to the hubs which were placed in the sewers. Besides helping to keep the records correct, this was a great help to the contractor as considerable time would have been lost if the engineer or inspector having the location of the connections was on some other part of the work. Where it was decided to carry the connection to the curb, the letter "C" was marked upon the curb or fence and at intermediate points where hubs only were to be placed for future connections, the letter "H" was marked upon the curb, after these connections had been inspected and approved, the letters were cut in the curb which would enable the plumbers to readily find the pipe. When the connection was inspected, the station was recorded, together with the length of pipe laid, the depth of trenching under the different classifications, the rock, special joints and any special work. From such data the engineer was enabled to prepare the final drawings, showing in detail, block by block, everything which would be required by the assessment commissioners in preparing their report of assessments, and by those in charge of the operation and maintenance of the sewer system. A record was also kept of all underground structures, such as drains, water and gas pipes, which might be useful in other improvements of the streets of the borough. A record plan and profile are reproduced herewith.

The backfilling was done with a back-filling machine, designed and built by Mr. Miller, of the firm of Martin & Miller. The trench was settled with a water jet, the water being furnished by the borough at the rate of $1.10 per 1000 cu.ft., measured by a meter attached to the hydrants. This method effected a big saving to the contractors as they could backfill a much greater length of trench per day than would otherwise have been possible.

Cost of a Damp-Proof Timber Floor

By J. Albert Holmes*

Engineers are frequently called upon to design and build floors in industrial buildings where water under a head is not encountered, but where protection against dampness must be provided. This applies to basement and ground floors where the practice was formerly to carry such floors on heavy timbering, supported by piers, thus providing an air space and more recently by laying the floor directly on a concrete base and spiking to strips embedded in the concrete.

Neither of these methods prevent decay. More recent and extensive practice is to introduce a damp-proof construction under the wood surface directly on the ground. If water is present, a system of underdrainage is necessary, consisting of open-tile drains and broken stone or gravel on which is placed a foundation of broken stone, gravel, or cinders coated with sufficient tar to bind under light rolling.

Where the ground has sufficient natural drainage and no tile is required, the foundation course is laid directly on the ground. On this foundation is spread a layer of tarred sand in which planks are bedded by ramming and on which the hardwood wearing surface is laid and nailed. A floor of this character provides a rigid foundation for machinery and will support the heaviest materials in storage. Many of these floors are in use in mills and factories throughout New England.

The writer recently built a damp-proof floor of this kind by day labor, on which a careful record of cost was kept. The floor was laid in the basement of a manufacturing building on the natural earth, hardpan and sand, without underdrains, and carrying machinery, round steel in racks and square steel piled solid in storage.

The owner, wishing to secure a long-lived floor, purchased kyanized hemlock for the 3-in. underfloor and had two-ply felt and a layer of pitch placed between the plank and top flooring. The ground was prepared by the contractor for the building by rolling or puddling, therefore, the costs given in the accompanying table are for materials and labor above the ground.

The soft-coal cinders used for the foundation course were purchased from the railroad and delivered in cars on a siding from which they were shoveled directly into the basement where used. Materials were delivered and the work performed in the winter, so that storage in the basement obviated the necessity of heating the cinders when mixed with the tar. Tar was purchased from the local gas works and 14 gal. used per cu.yd. of cinders.

The cinders were spread, rolled and tamped to a thickness of 4 in.; the shrinkage from measurement in cars to place was 36%. Sand and tar were heated outside the building and mixed in the basement. This mixture, while warm, was spread over the cinders and screeded off 3/8 in. above the bottom of the plank; planks being laid to grade for screeding. Into the sand while still warm, the 3-in. planks were firmly bedded by ramming.

For specially prepared tars, 50 to 60 gal. per yd. of sand are specified. On this work the greatest amount of tar that the sand could be made to contain, without making a soft, wet mixture, was 35 gal. per cu.yd., the same kind of tar being used in both cinders and sand. The writer has knowledge of floors where the tar has come up through the joints in both plank and top floor due, no doubt, to an excess of tar in the sand.

The difference in volume of sand in place and in carts, due to compression and to inequalities of surface of cinder layer was 68%. The plank was 3-in. kyanized hemlock, planed one side to a uniform thickness of 2¾ in. and not less than 6 in. wide, random lengths, square edged and saw butted; laid to break joints and toe nailed but not driven tightly together. There was no loss of plank by cutting.

Over the plank were placed two layers of felt and one of pitch. The felt weighed 14 lb. per 100 sq.ft. and was laid to break joints one-half the width of the sheet; no pitch was allowed to come in contact with either plank or top floor. The loss in area of felt due to lapping was 21%.

Over the felt and at right angles to the plank was laid a maple-top floor 1 1/16 in. thick. This flooring was square edge, 3 in. wide, and nailed with 10-penny finish nails through the top every 8 in. on alternate sides.

*16 Chapel St., Somerville, Mass.

The waste and shrinkage due partly to laying, but mostly to manufacture, was 40%; in other words, while the market price of the flooring was $45 per M, the shrinkage in manufacturing that must be paid for, plus a small loss by waste in laying, brought the cost up to $63 per M. Builders are familiar with shrinkages in manufactured lumber, but engineers, not having occasion to use it so frequently, are not so familiar and are surprised when as for instance, they purchase 5-in. V-sheathing for building a field office, to find that it covers a width of only 3¼ in. and that the Western rules for inspection of hard pine allow ⅛ in. less than the Eastern, which in turn allow an ⅛-in. or more, less than full dimension for square timber and plank.

Referring to the accompanying table, the quantities in Column 3 are the quantities purchased in the market, as for instance, 4 in. of cinders in place amount to 0.151 cu. yd. measured in cars, or 36% (in Column 6 of table) more than the place measurement and similarly for sand, felt and top floor, there being no loss in laying the 3-in. plank.

In this work, two distinct classes of labor or trades were employed, roofers in this case and carpenters, and though they worked together, their organizations were separate. For this reason, the combined items for superintendence is high and that for superintendence of roofers unnecessarily so. Reducing the item for superintendence of roofers and using untreated plank and leaving out the felt and pitch between plank and top floor, the cost would be reduced as shown in Column 7 of the table.

COST OF DAMP-PROOF FLOOR

1	2	3	4	5	6	7*
Materials and labor	Thickness of material in place	Quantity per sq.yd.	Unit cost	Cost per sq.yd.	Per cent. of waste and shrinkage	Cost per sq.yd.
Cinders	4 in.	0.151 cu.yd.	$0.50 per cu.yd.	$0.076	36	$0.076
Tar in cinders		0.0381 bbl.	2.00 per bbl. (57 gal.)	0.076		0.076
Sand	1 in.	0.045 cu.yd.	1.00 per cu.yd.	0.045	68	0.045
Tar in sand		0.0276 bbl.	2.00 per bbl. (57 gal.)	0.055		0.055
Felt	2 ply	3.10 lb.	35.00 per ton	0.054	21	
Pitch on felt		3.32 lb.	17.00 per ton	0.028		
Teaming, tar			0.50 per hr.	0.039		0.039
Labor, roofers			0.375 per hr.	0.433		0.358
Supt., roofers			0.50 per hr.	0.100		0.078
Kyanized plank	2¼ in.	0.027 M.	33.50 per M.	0.905	00	0.756
Maple top floor	1⅛ in.	0.0134 M.	45.00 per M.	0.603	40	0.603
Nails		1.2 lb.	2.10 per cwt.	0.027		0.027
Carpenters			0.41 per hr.	0.475		0.475
Labor			1.75 per day	0.230		0.230
Supt.			0.50 per hr.	0.080		0.080
Totals	9 in.			3.226		2.898
			Materials	1.869		1.638
			Labor	1.357		1.260

*Cost omitting felt, pitch on felt, labor placing felt and pitch and using untreated Hemlock plank @ $28.00 per M.

Australian Ironbark Pins in Pin-Keyed Joints

By H. D. Dewell*

The following account of the tests of two bolted and keyed timber joints using Australian ironbark (Red) may be of interest, as supplementing the tests described in Engineering News of Mar. 19, 1914.

The joints tested were as shown in Fig. 1, the pins being lathe-turned. The properties of the red Australian ironbark are given by a trade publication as follows:

*Chief Structural Engineer, Panama-Pacific Exposition, San Francisco, Calif.

	Lb. per sq.in.
Modulus of rupture in bending (54x6x4 in.)	17,600
Tensile strength	22,000
Compressive strength (12x3x3 in.)	9,500
Shearing strength (6x6x2 in.)	2,100

This wood has a straight grain, contrasting in this respect with the Hawaiian Ohia. The timber also has a much higher specific gravity than the Ohia.

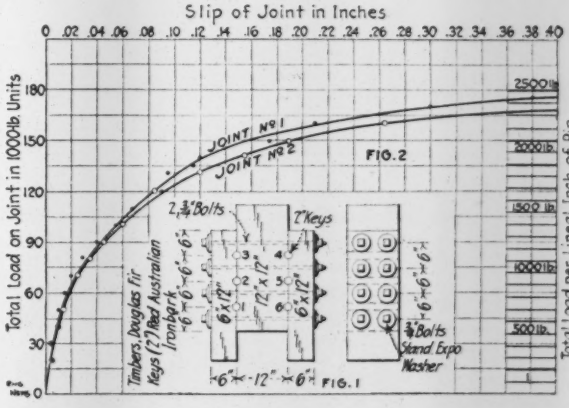
Referring to Fig. 1, pins 2 and 5 were placed with the grain vertical, pins 1, 3, 4 and 6 with the grain horizontal. The bolts were ¾ in., with standard Exposition washers (see the article above referred to). The following table gives the result of the tests:

COMPRESSION TESTS OF TWO PIN-KEYED JOINTS WITH IRONBARK PINS

(Six 2-in. pins 12 long, per joint.)

Load thousand lb.	Slip, in inches: Splice A	Splice B	Average	Remarks
JOINT 1				
10	0.0	0.0	0.0	
20	0.01	0.0	0.005	
110	0.08	0.06	0.070	
120	0.10	0.08	0.090	
130	0.11	0.08	0.095	Pin 2 slight crack
140	0.12	0.12	0.120	Pin 5 slight crack
170	0.30	0.30	0.300	Pin 1 slight crack
180	0.58	0.58	0.580	Max. load.
Load JOINT 2				
30	0.01	0.0	0.005	
40	0.02	0.0	0.010	
50	0.03	0.0	0.015	
140	0.20	0.11	0.155	
150	0.23	0.15	0.190	
160	0.31	0.22	0.265	Pin 2 cracked
168 Max.	0.58	0.49	0.585	Pin 2 sheared

Fig. 2 shows the load-deformation curves. While the curves show no very definite yield-points, the values of 1875 lb. and 1600 lb. per lin.in. of pin have been taken as representing the elastic limit of the two joints. The



PIN-KEYED JOINTS FOR TEST OF RED AUSTRALIAN IRONBARK PINS, AND CURVES OF RESULTS

working value of these pins in design was taken at 800 lb. per lin.in. of pin, representing a factor of safety of 2 on the yield-point.

The failure of the joints was due primarily to the crushing of the Douglas fir. While both the maximum load and the yield-point load per unit length of pin were less than those shown in the Ohia pins (6 in. long) of the previous tests, an extended series of tests alone would determine the relative efficiency of the two timbers.

The above tests were made for the Panama-Pacific International Exposition by the civil-engineering laboratory of the University of California and were used in connection with the framing of the timber portion of the Main Entrance Tower.

Chicago Bridge Work by Day Labor

By Harry J. McDargh*

SYNOPSIS—The employment of the day-labor system for municipal construction work is on the increase, and in Chicago this system has been adopted with success on extensive sewer work and some bridge work, while it has been decided to adopt it also for one of the new water-intake tunnels. The following article describes the construction of some fixed bridges over the north branch of the Chicago River by day labor.

During the year 1913, the city of Chicago constructed several fixed bridges by day labor. The term "fixed bridge" is used by the city to designate all types of bridges other than those constructed over the navigable parts of the Chicago River. There are seven fixed bridges over the west fork of the North Branch of the Chicago River within a distance of four miles, and this article relates to the construction of these bridges at their respective locations by the use of day labor. Fig. 1 is a view of the Central Park Ave bridge.

Fig. 1. Bridge at Central Park Ave., West Fork of the North Branch of the Chicago River
(Typical of seven bridges built by day labor under the Department of Public Works, Chicago.)

The bridges are all similar for six of the locations, and are of the plate-girder deck type with concrete substructures. Excavation for the substructure was made through loam, gravel and stiff blue clay to a depth of at least 8½ ft. below low water to allow for a possible future dredging of this stream.

The superstructure design is shown in Fig. 2. The main girders are 75 ft. 8 in. long, with the floor system designed to carry the heaviest city traffic. The roadway is 24 ft. between curbs, paved with 4-in. creosoted-wood blocks on 2-in. creosoted subplanking laid tight on 4x6-in. creosoted sleepers spaced 9 in. c. to c. The two 8-ft. walks are of reinforced-concrete flat-slab construction. The sidewalk railing on the bridge is of ornamental iron construction, and joins the concrete parapet walls carried on the wing walls of the substructure.

The wing walls of the substructure end in a circular return and come to within 2 ft. of the property line. All streets are 66 ft. wide. The esthetic treatment of both the substructure and superstructure was recommended by the Chicago Plan Commission, and the resulting structure is quite effective in appearance, as shown in Fig. 2.

*Assistant Engineer, Department of Public Works, Chicago.

The Commissioner of Public Works* is the executive head of the city of Chicago for work of this class. The City Engineer† is the executive of the Bureau of Engineering, and one of its departments is the Division of Bridges and Harbor,‡ under which division this work was done. The field organization consisted of an engineer (the writer) acting as general superintendent; an instrument man as time-keeper and material clerk; a foreman of carpenters, cement mixers and laborers and in charge of substructure construction, and a foreman of bridge and structural-iron workers in charge of erection of the superstructure. The rates of wages per hour (union scale) were 80c. for foremen, 72½c. for hoisting engineman, 65c. for carpenters, and 40c. for laborers.

Contracts were made in the usual manner for furnishing and delivering the superstructure steel and creosoted lumber at each bridge site. Sand, stone, gravel, cement, reinforcing steel and lumber were delivered to the bridges under requisition made on the city's yearly contract for these supplies. Smaller supplies, such as nails, wire, bolts, etc., were secured through the city purchasing agent.

Material costs under the contracts were as follows: cement, $1.20 per bbl. net; torpedo sand, $1.70 per cu.yd.; stone or gravel, $1.65 per cu.yd.; lumber (average) $29 per M ft. b.m.; superstructure steel, 2.61c. per lb. An additional charge of 2c. per bbl. on cement and 10c. per cu.yd. on sand, stone, or gravel was made for each mile or fraction thereof beyond a defined territory.

The plant consisted of a 10-ton stiff-leg derrick with a 42-ft. boom, a 16-hp. steam-hoisting engine, four 1-yd. self-dumping steel buckets, a steam pump, a gasoline-driven concrete mixer of 8-ft. batch capacity, and the other necessary smaller equipment.

The average depth of excavation was 26 ft. below the curb grade, and each pit was sheathed tight to blue clay, due to the water-bearing gravel and the proximity to the river. No extraordinary conditions were encountered. Excavation of the blue clay was laborious, however, as

*L. E. McGann, Commissioner of Public Works.
†John Ericson, City Engineer.
‡Thos. G. Pihlfeldt, Engineer of Bridges and Harbor.

it could only be loosened in small chunks by the use of mattocks. Keeping the clay water-soaked was found advisable.

Cost and Progress of Work

The substructures at N. 40th Ave. and N. 48th Ave. were started during the fall of 1912, but all work was suspended before the end of the year. Work was again started May 9, 1913, and three other substructures (at Central Park Ave., Kedzie Ave. and 56th Ave.) were completed during the year. The substructure at Forest Glen Ave. was 90% completed on Dec. 31, and was entirely completed Jan. 29, 1914.

The superstructure steel for N. 40th Ave. was delivered on the site July 2, the erection completed Aug. 12 and the roadway opened to traffic Sept. 1. Erection of 48th Ave. superstructure was started July 31, completed Sept. 3, and the roadway opened to traffic on Oct. 1.

The next superstructure steel arrived Oct. 21, and was erected at Central Park Ave. and this bridge opened to traffic on Dec. 20.

The steel for the Kedzie Ave. superstructure arrived on Dec. 4, erection was completed Dec. 27, and the roadway opened to traffic Feb. 14, 1914. Erection of the superstructure at 56th Ave. was started Dec. 29, completed Jan. 28, and the roadway opened to traffic Feb. 26. At Forest Glen Ave. the delivery of the steel was started Feb. 9, but was tied up until Feb. 20 by a strike on the company furnishing the material. Erection was completed Mar. 12, and the roadway opened to traffic on Apr. 7, 1914.

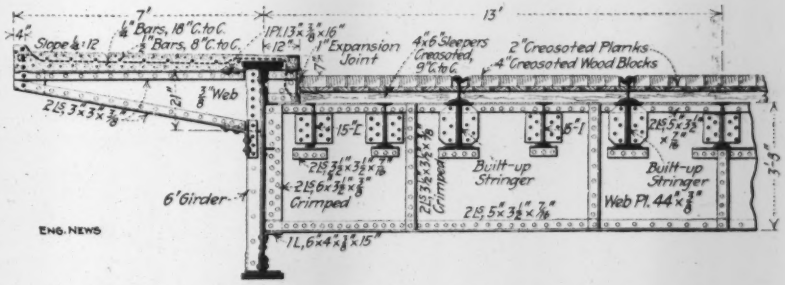


Fig. 2. Half Cross-Section of Plate-Girder Bridges over the West Fork of the North Branch of the Chicago River

The old structure at Kedzie Ave. was a wrought-iron through-truss bridge, 63 ft. long and 36 ft. wide over all, that had been used at another location. This truss was "house moved" to Foster Ave. and erected on timber bents set on concrete foundations. Its present location is an unimportant thoroughfare and it is expected that it will serve 10 yr. or more at this, its third place of usefulness. While being moved, the truss was carried on two sets of 12x12-in. timbers, 6 ft. c. to c., placed symmetrically to the center of the bridge. Using wood rollers on a timber runway and a crab, this 35-ton truss was moved 4300 ft. and set up on bents for $383.50.

For excavation, backfill, coffer-dam, sheathing and pumping, the cost on the several jobs varied from $1.23 to $1.55 per cu.yd. The substructure concrete (1:3:6) varied in cost as follows:

Labor for handling sand, stone and cement to mixer, mixing and placing in forms, $1.291 to $1.408 per cu.yd. Part of this variance in the cost of labor was due to the uneconomical method necessary in handling the material, as it was compulsory to keep the narrow roadways open and the material was scattered along the side of the road for a distance of 600 ft. from the bridge on each side of the river.

Material cost $3.778 to $4.558 per cu.yd. of concrete. This variance was due to difference in length of haul for delivery.

Forms, including labor and material, cost $1.580 to $1.986 per cu.yd. of concrete.

The erection of the steelwork was done without the aid of power machinery and all riveting was by hand. The cost varied from 0.75 to 0.77c. per lb.

The creosoted wood-block pavement with sub-planking and sleepers cost for material $4 per sq.yd.; the labor for placing averaged 81½c. per sq.yd. for roadways without car tracks and $1.40 on the roadway with car tracks.

The widths of the roadways leading to the bridges were in most cases about 18 ft. and these were widened to meet the approaches of the new bridge at a cost varying from 74.7 to 95.1c. per cu.yd.

Advantages of Day-Labor Work

It is only natural to inquire as to the advantage of doing this class of municipal construction work by day labor. The two important elements to consider are time and cost.

The old adage that "large bodies move slowly" is applicable to any corporation of the size of the city of Chicago. This is as it should be, for it is absolutely necessary that every precaution be taken to safeguard the city's interest by each of the several different departments having jurisdiction in the making of contracts. In contract work, considerable time elapses between preparing the plans and specifications, awarding the contract and starting the work, due to the different steps and procedures. A great portion of this work and time is saved with the day-labor system as the Commissioner of Public Works instructs the City Engineer to proceed with certain work, and the latter similarly instructs the Engineer of Bridges and Harbor, so that within a short time substructure work can be started. At the same time, detailed plans and specifications can be prepared and a contract entered into for furnishing the superstructure, which (with an ordinary condition of the steel market) can be obtained by the time it is needed.

It is not uncommon for the low bidder on some new work to be busily occupied with his equipment in an attempt to finish other contracts. This condition is the cause of a continuous fight on the part of city officials in an attempt to get the contractor to start the new work with such an organization as will guarantee the completion at the time specified. With the work being done by the city direct, the man in charge realizes that his own welfare is at stake if the proper progress is not made.

The cost of supervision in day-labor work is eliminated. The engineer and instrument man in charge of day-labor work would have the same relative positions in contract work. The two inspectors on contract work who supervise the proportioning of the concrete aggregates and the

placing of the same are eliminated. Also the inspectors on the erection of the steelwork and the laying of the roadway and sidewalk pavements.

Another source of saving is the middleman's profit in handling the superstructure material. Another advantage as regards time is due to the fact that when contracts are let for small jobs of this size, the low bidder is frequently a small contractor poorly equipped or new at the business, and although the city may get the benefit of a low bid, the contractor is working at a disadvantage and if at a small margin of profit, his whole aim is to work as cheaply as possible, and little attention is paid to the time it takes him to complete the work. This results in a general dissatisfaction to those living adjacent to the work and an increase in the cost of supervision.

Anyone connected with municipal contract work appreciates the dread of having to encounter extras. In day-labor work, there is no worry about extras. Even with the utmost precaution in preparation of plans and specifications, unforeseen conditions frequently arise and upset the best calculations. Operation under day labor permits changes to be made during construction, when the necessity occurs, without the accompanying regulation routine required on contract work.

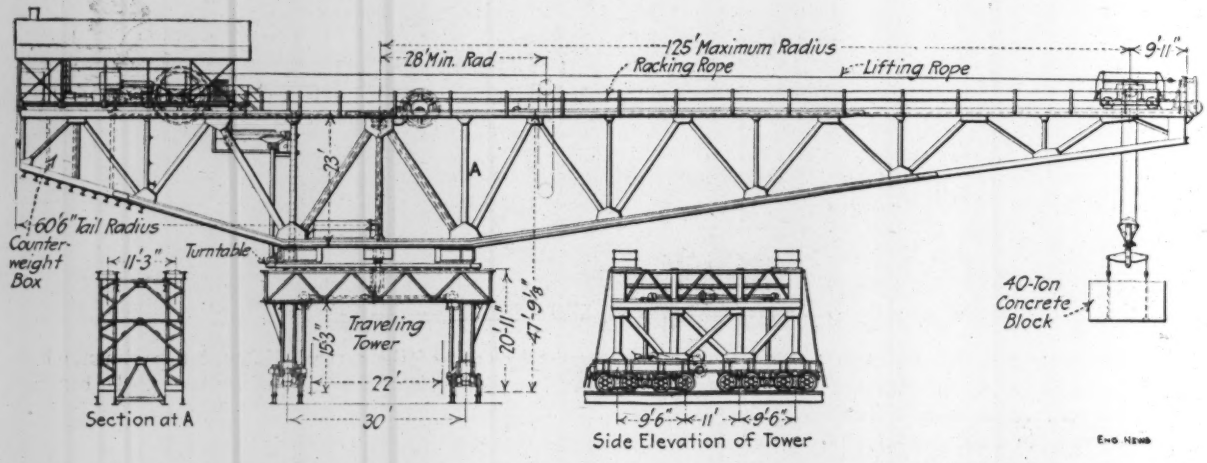
There is one important condition absolutely necessary to successful attainment on this class of work and it is the authority to retain only such men on the payroll as are capable of doing justice to the work assigned them. In this respect, the writer cannot give too much credit to his superiors for their support. There is an idea that municipal employees are not compelled to render equal service to that required by a contractor. When such a condition is found, it is due usually to the man in charge. The writer was not required to keep an inefficient or lazy mechanic on his payroll but was expected to dispose of such men immediately.

The Lime Product of the United States in 1913 was 3,595,390 short tons, valued at $14,648,362 according to a press bulletin issued by the U. S. Geological Survey. This was 65,928 tons more than the production in 1912 and the increase in value was $678,248. The average prices of lime per ton for the last three years have been: 1913, $4.07; 1912, $3.96; 1911, $4.03.

Revolving Cantilever Crane for Harbor Construction Work

The revolving and traveling cantilever crane shown in the accompanying cut belongs to a type of machine used very extensively by English engineers and contractors on the construction of breakwaters and other harbor work in various parts of the world.

This crane has a pair of trusses 11 ft. 3 in. apart, 185 ft. 6 in. long, with a working arm of 125 ft. and a tail or counterweight arm of 60 ft. 6 in., the latter carrying the engines and boiler and a counterweight box. The trusses are mounted on a live-ring turntable 31 ft. diameter on the top of a tower consisting of a heavy girder frame on a pair of side trusses. The crane travels on two tracks of standard gage, spaced 30 ft. c. to c., but instead of single rails for the tracks there are double rails carrying 36-in. wheels which have wide flat tires with central flanges riding between the rails. There are four four-wheeled trucks on each track, or 32 wheels in all. Each pair of rails is secured to a bed-plate on a pair of I-beams.



TRAVELING AND REVOLVING CANTILEVER CRANE FOR SETTING CONCRETE BLOCKS ON HARBOR WORK AT FISHGUARD, ENGLAND

(Stothert & Pitt, Bath, England, builders.)

The main engine has cylinders 11x18 in. It operates the hoisting cable, the cable for racking the trolley along the boom, the swinging gear and the propelling gear. The latter consists of bevel-gear drives to four countershafts (between the trucks), from which the axles are driven by chains. It has an 8-part hoisting tackle, with a vertical reach of 80 ft., and can hoist 40 tons at 8½ ft. or 7 tons at 48 ft. per min. The trolley has a travel of 97 ft., and can run at 22 ft. or 45 ft. per min. with the above loads. The crane can travel at 42 ft. per min. with a 40-ton load, and can make a complete revolution in three minutes. The box in the short arm contains about 100 tons of pig iron for a counterweight.

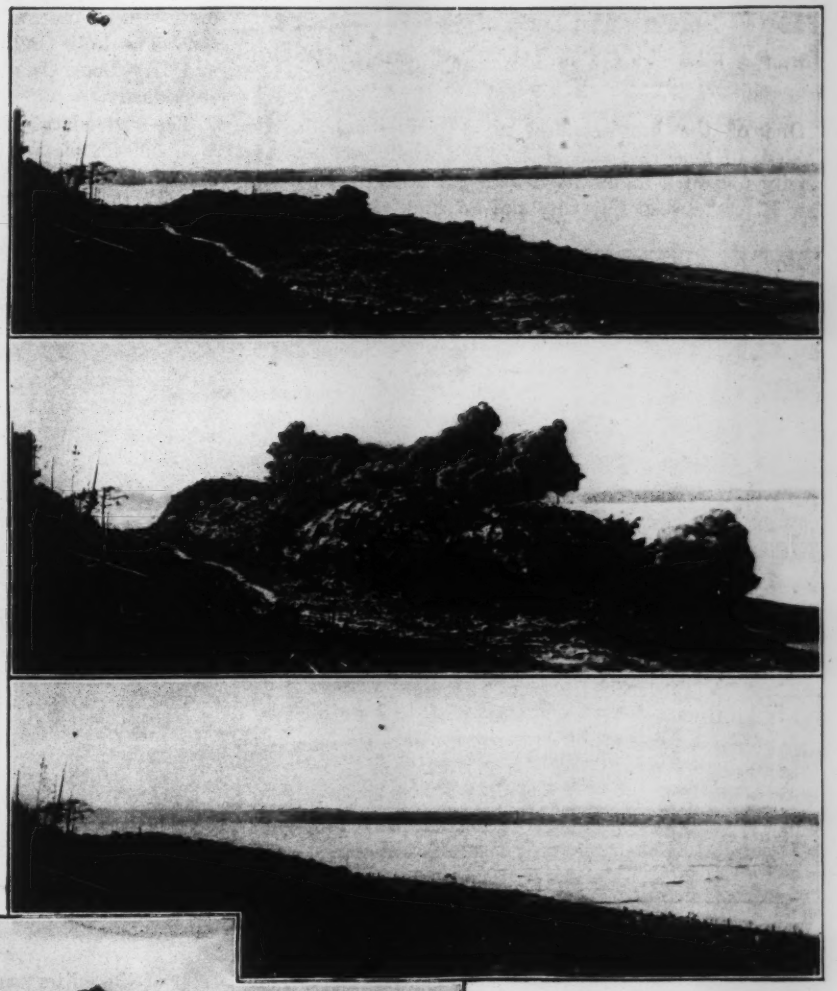
This crane is to be used in setting stone and concrete blocks for the harbor work of the Great Western Ry. at Fishguard, on the Welsh coast, for which Topham, Jones & Railton are the contractors. It was built by Stothert & Pitts, of Bath, England, and was tested with 50-ton loads after completion.

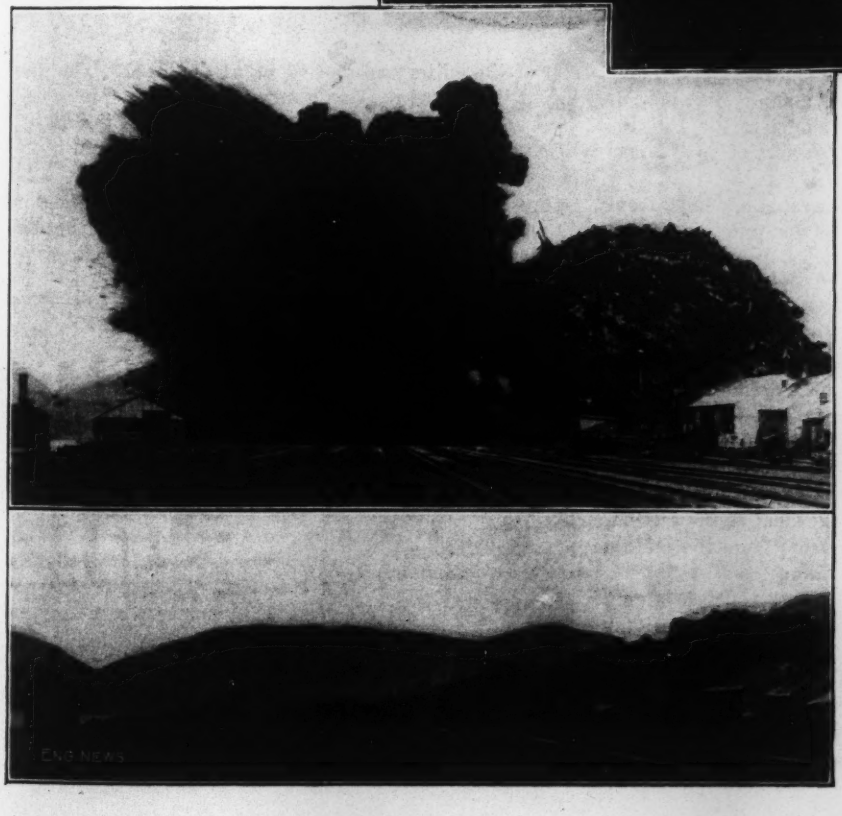
Our information and drawing are from *The Engineer*, of London.

Some Remarkable Photographs of a Large Blast

The accompanying five illustrations show in a remarkable manner the progress of a large blast of 125 tons of black powder. The illustrations on the right are taken from one side of the hill to be removed and the two lower pictures on the left are taken from the opposite side.

The upper picture represents the ground surface before the explosion. The second picture was taken at the instant of the explosion, before the explosive gases had fully commenced to break through the earth crust. The third picture on the right shows the broken surface after the blast. The two lower pictures are self-explanatory and give a very fair idea of the amount of rock removed.





The blast was a part of the construction work on the Prince Rupert, B. C., terminal of the Grand Trunk Pacific Ry., done last winter by Foley, Welch & Stewart, Contractors, of St. Paul, Minn., and Vancouver, B. C. For the photographs we are indebted to Wm. T. Donnelly, Consulting Engineer, New York City, who is building a large dry dock at Prince Rupert, a description of which was given in ENGINEERING NEWS, Jan. 4, 1912, p. 1.

The general character of the shore of Prince Rupert is bold and rocky and the railway entrance required some heavy grading. The Grand Trunk Pacific Ry. reaches the coast by the Skeena River valley, about 15 miles to the south, and, crossing to Kaien Island, where is located Prince Rupert, at its southern end, closely follows the shore to and along the water front of the city. Where four years ago was a complete wilderness is now a thriving city and seaport of several thousand inhabitants and many business institutions.

The Hydraulic Dredge "Niagara" and Its Work in the Saginaw River

One of the heaviest and most powerful hydraulic dredges of moderate size is the "Niagara" designed primarily for work in the hard material beneath the Saginaw River between Bay City and Saginaw, Mich.

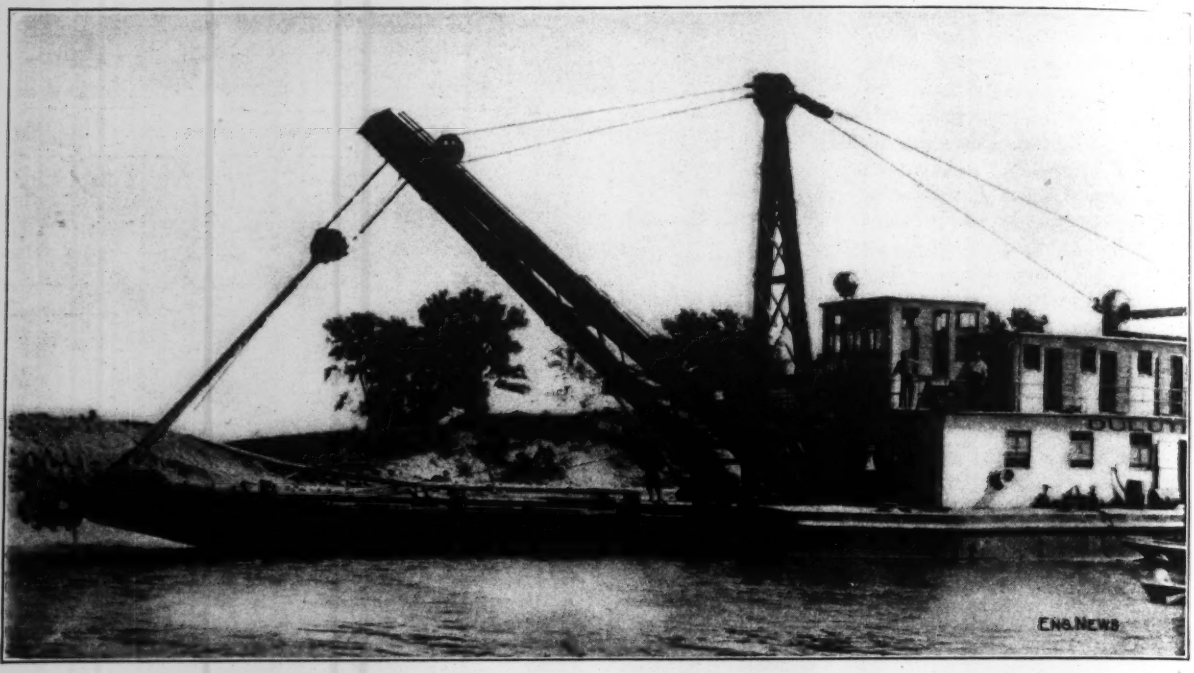


FIG. 1. FORWARD END OF DREDGE "NIAGARA"

This work is underway by the U. S. War Department and contract was let to G. H. Breyman & Bro. of Toledo. One of the two sections was sublet to the Duluth-Superior Dredging Co., of Duluth, owners of the "Niagara."

The channel which is being excavated extends from the 18-ft. curve in Saginaw Bay to the junction of the Tittabawassee and Shiawassee Rivers, a distance of 21¼ miles. This channel is to be 200 ft. wide at the bottom and 18 ft. in depth. The total excavation amounts to over 4,000,000 cubic yards, of which 3,375,000 cu.yd. is included in Section 2 sublet. Breyman Bros. did their portion of the work with two dipper dredges; it comprised that part of the channel from Bay City to Saginaw Bay. The Dulufth-Superior Dredging Co. is working two 20-in. hydraulic dredges, the "Niagara," mentioned before, and the "Enterprise." The former is being used on the hard material on the lower end of the section, and the latter in softer digging, working from the middle up toward the upper end of the section.

The material encountered on Section 2 consists largely of sand and clay for a distance of about ten miles; for the remaining six miles it is a very hard indurated clay, or hardpan, with a large quantity of stones of various sizes. However, the "Niagara" was designed for digging this material and the contractors and engineer officer are satisfied with the way it is being handled.

The greatest interest in the "Niagara" lies in its dredging equipment, which was developed by the Bu[illegible] Co. The hull (built by the Manitowoc Ship Bu[illegible] and Dry Dock Co.) and other machinery, is of in[illegible] secondarily.

The cutter head (Fig. 3) is unusual. It is a six-bl[illegible] type 100-in. diameter, and of nickel-chrome steel. [illegible] blades carry socket-fitted teeth, three on one blade [illegible] four on the next. The cutter shaft is 11½ in. in d[illegible] eter at the cutter end and 10 in. at the other. The gearing at the top of the dredging arm is mounted on a cast-steel bedplate for rigidity. The suction arm is a 77,000-lb. plate girder (see Fig. 1). The A-frame, braced booms, etc., have all been made correspondingly heavy. The pump is extra heavy (of nickel-chrome steel) weighing 71,000 lb. exclusive of engine. The casing is unlined. The engine is a 1000-hp. triple-expansion marine type

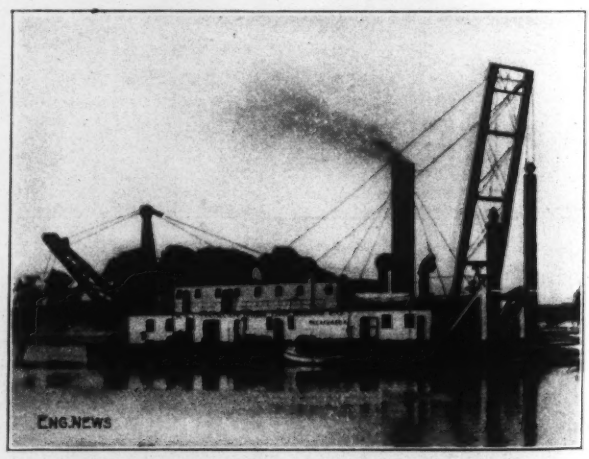


FIG. 2. AFTER END OF DREDGE "NIAGARA"

(built by Marine Iron Works of Chicago); it has a speed of 200 r.p.m. and can pump the dredged material through a 5000-ft. pipe line 10 ft. above water.

The cutter engine is a double-cylinder 12x15-in. type of heavy construction for 200-lb. boiler-gage pressure. The cutter gears are large and extra heavy. The spuds (Fig. 2) are of ¾-in. steel pipe, lap-welded, 39½ in. in diameter and 67 ft. long. They carry cast-steel points.

The hull is 135 ft. long and 11 ft. deep, with 43-ft. beam. There are two longitudinal bulkheads from end to end and three transverse. Coal bunkers are in the side compartments below deck and abreast of the boilers. To minimize vibrations, the engine and pump foundations are built on high floors across the hull. The ladder well forward is made of ⅝-in. shell plate and heavily braced. Trolleys over the engine and pump facilitate inspection and repair. Over the machinery and boilers is a two-story steel deck house. The lower house has the kitchen, dining room and crew's washroom. The upper house has the officers' washroom and bath and sleeping quarters for 36 men. The operating room is forward and elevated; the many large windows give the operator unobstructed view of the work.

The general plan of operation is similar to any other hydraulic dredging job. The material excavated from the channel is pumped on to the bank of the river to form a levee upon which is to be built a road connecting the cities of Saginaw and Bay City.

The "Niagara" started digging June 5, 1913, and dug until it was laid up for the winter on Dec. 23. During this period it worked 3018½ hr., and was delayed for various reasons, 1008½ hr. All but 193 hr. of the time charged to delays was consumed in shifting pipe lines and in the other normal operations which necessitate stopping the pump. Of this 193 hr., the major portion was due to the wearing out of the pump casing and parts of the suction and discharge pipes which pass through the hull, due to the unusually hard character of material pumped.

FIG. 3. CUTTER HEAD OF DREDGE "NIAGARA"

During this working season, the dredge excavated a channel 14,600 ft. long to a depth of about 17.5 ft., with an average width of 235 ft. The maximum depth of cutting was 7.4 ft., and the total amount of material removed, 910,000 cu.yd., of which 730,323 was pay material, the remainder being taken outside of specified channel lines.

The dredge "Enterprise" dug 940,000 cu.yd. between Apr. 22 and Dec. 13.

Washington, D. C., Street-Cleaning Methods

BY J. W. PAXTON*

SYNOPSIS—This is the third of the series of articles describing Washington municipal street-cleaning methods. The previous articles appeared in ENGINEERING NEWS *of July 9 and Aug. 6. This article describes the office methods of planning and keeping in touch with the field work.*

OFFICE METHODS

UNIT OF WORK DONE—In order to obtain unit costs, it was necessary that a measure of the street-cleaning work done should be established. It was hoped that a unit could be found in which elements of the area swept, amount of dirt collected, length of haul, etc., would be combined in a proper proportion, but this still seems impracticable.

Former contractors were paid by the 1000 sq.yd., and as this unit was generally used elsewhere, it was thought advisable to adopt it for purposes of comparison. However, suburban street cleaning more than any other, brings out the faults of such a unit based on area alone. When a street is very dirty or washouts occur, most of the effort is expended in loading and hauling, and at times only 1000 or 2000 sq.yd. are cleaned per day, while under favorable conditions the area may run as high as 50,000 sq.yd.

STREET INTERSECTIONS—Formerly in making payment to the contractor, it was necessary to have accurate and official information of the areas of streets and alleys, which was obtained from the Surface Division of the Engineer Department. For purposes of computation, it was necessary to divide the area of each street into small sections, the most convenient being the areas between cross streets and the intersections common to two or more streets (Fig. 1). This information, together with the kind of pavement, is arranged on white cards 5x8 in. in size, ruled for four rows of three columns each; the column heads are "limits," "area" and "pavement" (kind of).

Street intersections carry the traffic from at least two

*Superintendent of Street Cleaning, Washington, D. C.

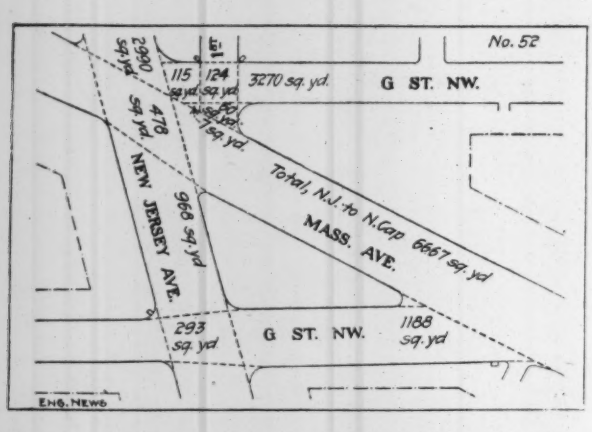


FIG. 1. PART OF A SURFACE DIVISION MAP, SHOWING METHOD OF DIVIDING STREETS INTO STREET CLEANING AREAS

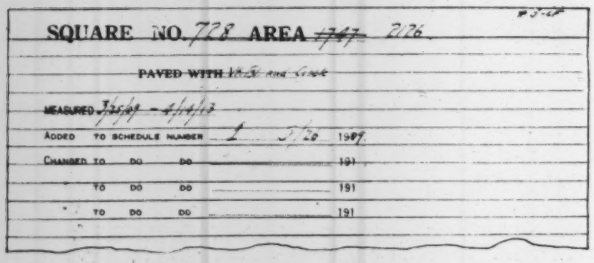


FIG. 2. FRONT FACE OF ALLEY CARD

streets and it is reasonable to suppose that they need twice the amount of cleaning. As a matter of fact, they are cleaned twice as often as the remaining portions in almost every case; and in allowing for area cleaned, they are so credited.

ALLEY MEASUREMENTS—For alley measurements, a 5x8-in. index card has been arranged, which shows on the face, the square number, area and kind of pavement, date measured, and the records of the schedules on which the alley in such square appears (Fig. 2). On the reverse side is a plot of the alley (Fig. 3). This plot is not

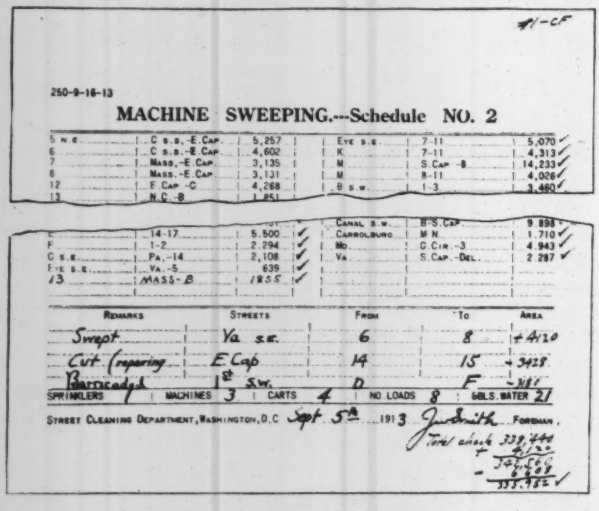


FIG. 4. SCHEDULE FURNISHED ALL BUT HAND PATROL AND ALLEY FOREMEN

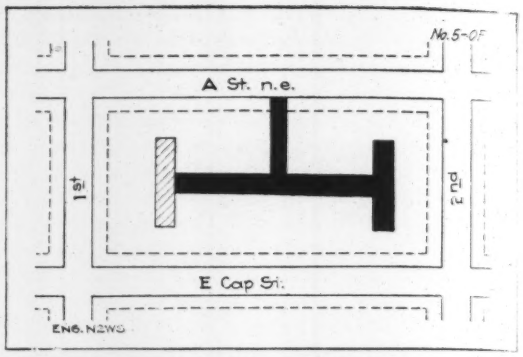


FIG. 3. REVERSE SIDE OF ALLEY CARD

strictly to scale but is valuable in showing exactly what is included in the measurement given.

In many cases, a number of private alleys open on a general public alley, but are not cleaned. From time to time, these private alleys are made public and then added to the schedule. In the illustration shown, the area originally cleaned is solid; the cross-sectioned portion was condemned and added to the schedule nearly four years later, so the face of the card shows both the original and new areas.

SCHEDULES—Each foreman, other than those of the hand patrol and alley gangs, is furnished with a schedule (Fig. 4), printed on green paper 8½x14 in., on which the areas of the streets are printed. The foreman checks off the portions of the streets as they are cleaned, fills in the spaces for information in regard to equipment, quantities of dirt removed and water used and returns the schedule to the office, where the total area is figured and credited to his gang.

It is not practicable to print the schedules in the order in which the streets are to be cleaned, as delays for any reason would disarrange any regular route. Regular intervals must exist, however, as far as possible, between the cleaning of each street.

The schedules for alley cleaning differ from those for machine-broom cleaning, only in the fact that they are printed on white paper and the square numbers and boundaries replace the names of the streets. The squares are arranged in rotation, and must be cleaned in the given order. The hand-patrol area is entirely covered each day, so no schedules are required.

Schedules are made up in the office, plotted on maps covered with sheet celluloid (giving a perfect erasure), criticized, refined, and then printed on a multigraph machine. Of the final maps which result from this study, one is kept of the hand-patrol areas and subsections, one of all machine-broom and washing territory, a third of the suburban and oiling territory and a fourth of the alleys. A combination map is also kept on which the kind of attention given each street is shown at a glance.

All schedules are considered as orders to the foremen. If temporary or permanent changes are to be made, a blank form properly filled in describing these changes, signed by the Superintendent or one of his asistants, is issued to the foreman, who uses this form as his authority until its expiration, or until new schedules are issued on which the correction has been made.

GRAPHICAL RECORDS—Information is often desirable as to the dates on which certain streets or alleys have been

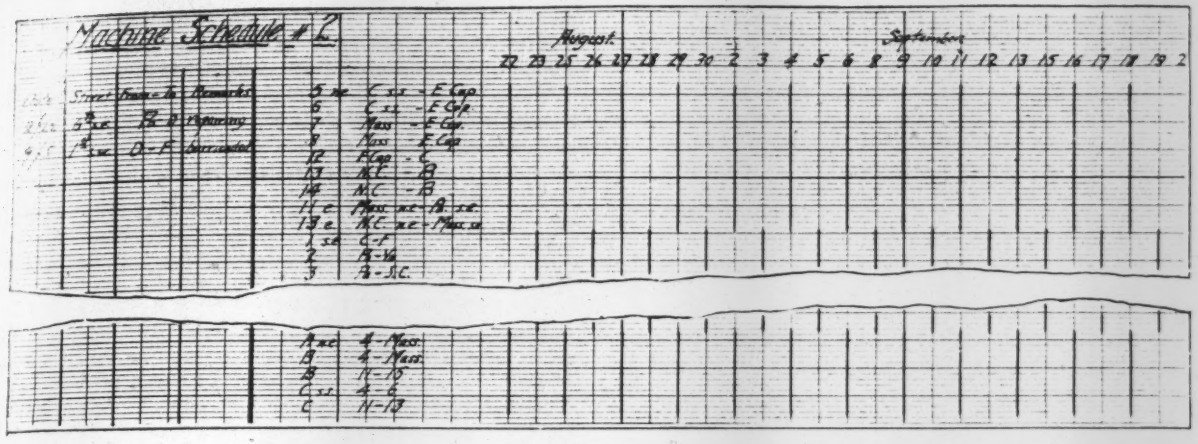


FIG. 5. GRAPHICAL METHOD OF KEEPING TRACK OF STREETS CLEANED, AND OF SEEING THAT SCHEDULED ATTENTION IS GIVEN TO EACH

cleaned, or streets washed or oiled. Previously this necessitated a long search of old schedules, but a simple graphical method of keeping this record has been devised, which is also useful in showing at a glance whether streets have received regular attention for extended periods.

On the machine schedule (Fig. 4), Second St., S. E. from Pennsylvania Ave. to Virginia Ave. is checked, indicating that it was cleaned on Sept. 5. This is shown in the graphical method devised to keep track of streets cleaned (Fig. 5) by a vertical line opposite the street and under that date. From machine schedules of other dates, similar information is plotted, showing this street was also cleaned Sept. 8, 10, 12 and 15. One such plot is kept for each street-cleaning gang, whether machines, alley, suburban, or washing; each plot usually running for three months.

Apparent errors on the part of the foremen in checking streets cleaned are very likely to be caught up in making this profile. A printed correction slip has been adopted to call to the attention of the field force any such errors which may appear, this slip being made up by the clerk who keeps the profile, and it is sent out to the foreman who then writes an explanation on the slip and returns it to the office.

The area cleaned, dirt removed, equipment employed and water used, as reported on these schedules, is posted daily on the Work Summary Sheet (Fig. 6). From the Time Reports (described in the article in ENGINEERING NEWS, July 9, 1914), the number of men employed and the hours worked are obtained semimonthly and this information likewise entered on the form, Fig. 6, giving a complete record of the physical work performed, etc. The hand-cleaning foremen, not having schedules, the dirt collected is reported by them on the Sack Report (Fig. 7).

Nov.	#1 Machines					Backwash		Area	#2 Machines					Kluster		Area	#3 Machines					Leafl		Area	#4 Machines					#3-CF Sharp		Area	Nov.
	Spr.	Mach	Carts	Men	Hours	Carts	Hours		Spr.	Mach	Carts	Men	Hours	Carts	Hours		Spr.	Mach	Carts	Men	Hours	Carts	Hours		Spr.	Mach	Carts	Men	Hours	Carts	Hours		
1	-	3	5	13	8	25	-	275,845	-	3	5	13	8	18	-	268,952	-	3	5	13	8	15	-	282,113	1	3	5	16	8	10	10	293,154	1
2	1	3	5	14	8	30	24	285,173	1	3	5	14	8	20	25	270,040	1	3	5	13	9	20	32	287,775	1	3	6	16	8	32	22	294,197	2
4	1	3	5	14	8	20	29	270,944	1	3	5	14	8	20	26	272,061	1	3	5	13	8	20	29	272,672	1	3	5	15	8	18	20	293,155	4

FIG. 6. SUMMARY OF WORK DONE AND FORCE EMPLOYED

500 8-19-13 #2-CF

STREET CLEANING DIVISION

WASHINGTON D C

SACK REPORT

E. S. Holland FOREMAN

SECTION #3 FROM Nov. 5th TO Nov. 10th 1912

ROUTE	WORKED BY	5	6	7	8	9	10				TOTAL
1	Z	20	18	19	17	18	17				109
2	"	18	17	16	18	17	19				105
3	"	18	14	15	19	16	17				101
4	"	25	23	28	23	20	27				146

FIG. 7. REPORT OF DIRT COLLECTED ON HAND PATROL

One-Inch Sheet Asphalt on a Concrete Base—The California State Highway Department is surfacing a part of the main coast road south from San Francisco with 1-in. of sheet asphalt laid on a 5-in portland cement concrete base. This section of road is in the suburbs of San Francisco and is designed to carry a moderately heavy city street traffic, about 75% of which is motor vehicles. The old roadway was built of waterbound macadam. 12 ft. wide and 6- to-12-in. deep. The new pavement is 24 ft. wide with 8-ft. earth shoulders. The maximum gradient is 4%. The foundation is 1:3:6 concrete; after the foundation is thoroughly set it is painted with a hot liquid asphalt mixture composed of one part by volume of asphaltic cement to two parts of engine distillate. The asphaltic cement is first heated to about 325° F., and when it is cooled to 250° F. the distillate is added and mixed in. This mixture is poured on the concrete surface from buckets. The consistency of the paint coat is made to vary with the porosity of the concrete surface. On this binder coat is laid the 1-in. course of asphalt mixture composed of sand, limestone dust and asphaltic cement. This is heated and put on at a temperature as close to 325° F. as possible. The very thin layer cools so rapidly that it is necessary to follow the hot hand rollers with a 5-ton or 8-ton steam-roller just as soon as can be done. The binder paint coat was a late addition to the specifications. It was found that the 1-in. surface on the asphaltic paint binder moved or melted very little under the roller as compared with that laid directly on the dry concrete. Although the economy of this type of construction is yet to be proved, it has thus far given every assurance of being well adapted to conditions. [Information taken from an article by E. B. Rine in the "Iowa Engineer."]

Construction Camp for the Town of Torrance, Calif.

By Ralph Bennett*

In the construction of localized works of considerable magnitude, such as long tunnels, power houses, dams and similar structures remote from cities of considerable size, it is necessary for the employer to make provision on a considerable scale for the relatively permanent residence of large numbers of men. These towns, or camps as they are commonly called, should be as inexpensive as is consistent with proper housing.

A camp, whether temporary or permanent, should be located on gently sloping ground which will provide satisfactory drainage.

The most important requisite is water. Provision should be made for securing a supply which will be ample and uncontaminated during the entire duration of the work. Water should come to the camp under sufficient pressure for ordinary tank use and should be supplied through pipes 3 or 4 in. in diameter so that one or two fair-sized fire streams can be used. There should be a 2-in. hose outlet with 100 ft. of 1½-in. cotton factory fire hose located to cover every building.

As a matter of fire protection, as well as of convenience, all buildings should be wired for electric lights, and the use of lanterns should be restricted to those classes of work which require portable outdoor lights.

Tents are not of sufficient durability and do not afford a comfortable enough shelter for use except in summer camps. The construction for permanent camps need not necessarily be of heavy material. It should in fact be of as light material as is consistent with necessary rigidity. The buildings should be of cheap lumber and should involve the least possible amount of labor. The salvage material should be of value for other work.

The accompanying illustrations show a series of buildings designed by the writer for the use of the Dominguez Land Corporation's employees in the construction of the town of Torrance (see Fig. 1 for general layout).* The buildings are intended to be occupied intermittently during a period of several years by a force of from 40 to 100 men. Their construction is believed to contain some features of merit. The designs involve the use, without cutting, of stock sizes of material for nearly all portions of the buildings.

The structures composing a permanent camp are usually a cook house, dining room, one or more bunk houses, a stable for horses and a commissary or company store. To these there is frequently added a wash house and sometimes a number of cottages for married men.

Cook House and Dining Room—In the cook house, the item of most particular interest is the roof and window arrangement. A shed roof is considerably cheaper to build than any other style. In the design shown (Fig. 2), necessary stiffness is secured for both the roof and the building by the use of a simple nailed truss under every rafter. The window openings are practically continuous, are screened on the outside and have the sash mounted against the inside of the boarding without frames. These sashes can be leaned back during the summer or pulled up to close the openings, as the climate warrants. This side of the cook house should preferably face the east or northeast in order to obtain the early morning sunlight without becoming overheated during the afternoon. The high windows furnish an even light on all tables and produce satisfactory ventilation with but little draft. In a cook house larger than the one shown there should be a door opposite each runway. All doors must be of ample size and arranged to swing out. All openings must be screened.

*Consulting Engineer, Los Angeles, Calif.

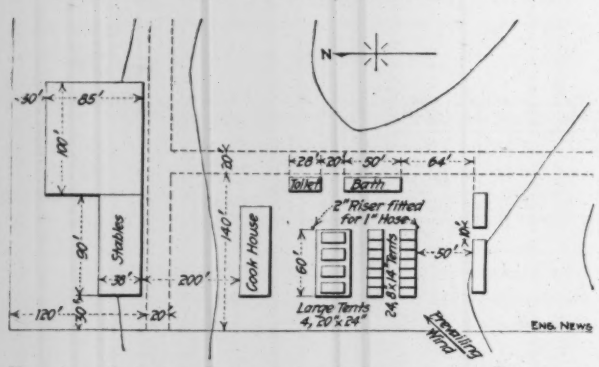


Fig. 1. General Layout of Construction Camp for Town of Torrance, Calif.

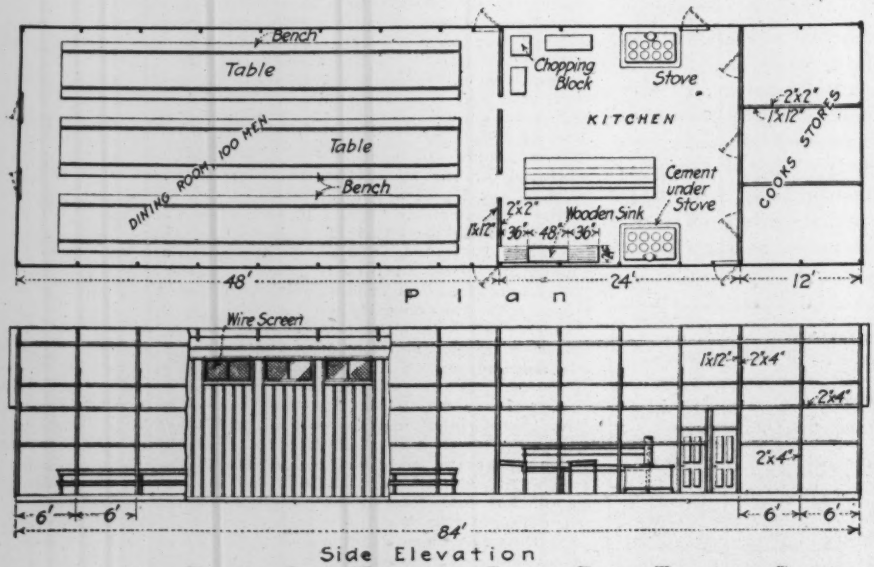


Fig. 2. Cook House and Dining Room, Torrance Construction Camp

*Previous articles on this new town may be found in "Engineering News" of Oct. 30 and Dec. 4, 1913, and Jan. 22, 1914, the latter under the title "Office Methods in Planning and Building a New Town."—Ed.

The main stove should be of ample size and should be set on a concrete or brick or rock base large enough to be safe from accidental ignition. Distillate-burning stoves are now universally used on the Pacific Coast. They are more economical, even in the woods, than wood or

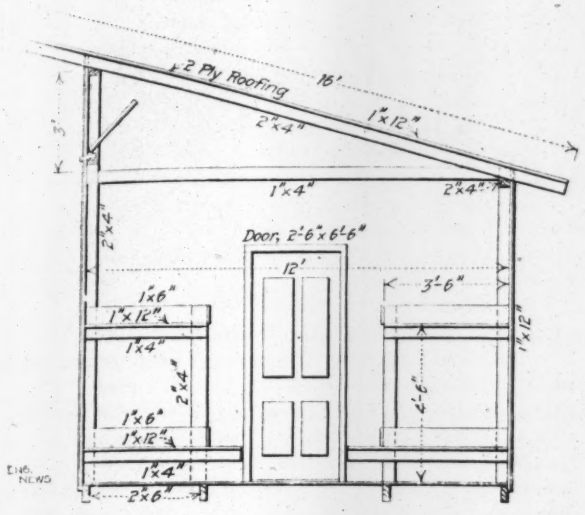


FIG. 3. CROSS-SECTION OF BUNK HOUSE, TORRANCE CONSTRUCTION CAMP

coal stoves, the fire produces a better heat and the cooking is more even. The stove should have a water-back with large storage-tank.

The larger the sink and drainboard the less trouble there is in retaining flunkeys. The tables should be covered with white oilcloth. White enamel ware appears to give better service than any other style of table furnishing. Benches and tables should be substantial. The tables should be 4 ft. wide. This class of furniture is thoroughly satisfactory for camp use.

If, as is now frequently the case, the management provides and occasional lecture or moving-picture show, this, high-ceiling room is quite satisfactory.

BUNK HOUSE—The bunk house (Fig. 3) is in its general arrangement typical of a large number of bunk houses in use in California. The use of a shed roof with high windows furnishes better light and air than does the old-style peak roof. In this particular house the bunks are unusually commodious and are provided with a continuous seat alongside of each lower bunk in preference to a single central bench. Steel bunks are sometimes substituted for the wooden frames. They have the advantage of being vermin-proof, but the disadvantage of leaking loose straw and other material more or less continuously. Except in very severe climates, no stove should be permitted in a bunk house. If there is a very considerable number of employees, the construction of a number of medium-sized bunk houses is much to be preferred to the use of a single large building. The loss in case of fire is less and the men are better satisfied in that they can separate by nationalities and trades.

Certain classes of employees, such as cooks, stable men, foremen and superintendents, require separate houses in any case. Shed-roof buildings of the same type can be used but subdivided crosswise into the necessary number of apartments.

LOAFING ROOM, BATH AND WASH ROOM—A combined loafing room, bath and wash room should be constructed in a camp housing less than 100 men. In larger camps these can be separated to advantage. The stove here should have a water-back to supply water for the shower baths and for washing the mens' clothing. There should be with it a tank of very considerable size. If the employer furnishes small wash tubs in place of the traditional 5-gal. oil cans, the men will appreciate them. For washing the face and hands, there should be a row of faucets located out of doors in the sun above a wooden trough equipped with graniteware wash basins.

SANITATION—The sanitation of the camp and minor policing should be in charge of a sweeper or sweepers who would clean up daily, supply necessary wood and start the wash-house fire before the end of the day. He should keep all buildings locked during the day and when unoccupied.

Ample supplies of disinfectant should be allowed and there should be a periodical whitewashing of the entire property.

Night shift employees should be, so far as is possible, segregated into a separate bunk house.

Water closets equipped with first-class plumbing should be installed in any camp where the duration of the work will warrant it. They are more sanitary and agreeable in every way than the best possible sinks, and have the very great advantage that they can be so screened as to minimize the possibility of fly-transmitted infection.

The most serious foe of health in the camp is the fly. Flies live on garbage and breed in manure. Manure should be hauled away daily and garbage should be kept covered. A number of fly-traps similar to the one shown by Fig. 4 should be located around the camp and emptied very frequently. The trapped flies can be stunned by dashing distillate or gasoline into the cage and can then be shaken out and burned.

STABLES—A camp of any size employs a large number of horses and they, with their feed and equipment, occupy a stable of considerable magnitude. The preferred arrangement of camp stables places the mangers lengthwise of the center line with the feed on one side and the animals on the other. Center-post construction will be

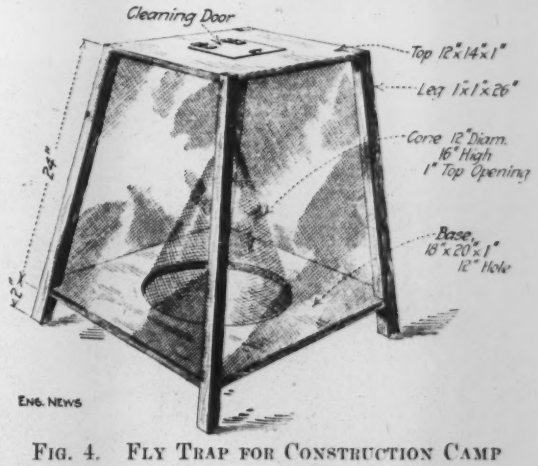


FIG. 4. FLY TRAP FOR CONSTRUCTION CAMP

more economical here than a single-span shed roof. If the stalls are on the south side of the building and are somewhat sheltered from the prevailing wind, that side of the stable can be left almost entirely open. The depth back of the animals should be ample for a convenient

runway. The harness of work animals is almost always hung on a bracket opposite the animal, but there should be a locked harness room for storing and repairing spare equipment. The bigger the corral and the more use there is made of it, the less trouble there is in maintaining the health of the animals. A great many horse diseases are communicated by dirty water in drinking troughs. Series troughs should not be used on account of this possibility. Small short individually filled troughs emptied and cleaned daily are much to be preferred.

Most of the miscellaneous wagons used by a modern camp are of the type known as heavy farm wagons. These can now be had all steel with roller bearings at a less price than in any other form and require not over two-thirds as much tractive power and require but very little maintenance or upkeep.

Gasoline Tractors for Southern Road Work

By G. B. Buchanan*

While gasoline power has been in use on Northern and mid-Western road work for several years, its introduction into the Southern States, and especially the southeastern tier of coastal states is very recent. One of the first tractors to be purchased by a county for use on the roads of Virginia was bought by Caroline County last year. Some observations of its work, cost and economy should interest road builders in other parts of the South.

Conditions of Work—A tractor for use on Southern roads must have a broad range of uses. County road work heretofore has been done generally in a crude, slipshod way, with mule teams and hand labor. The roads are narrow, curves sharp and grades steep. There are few culverts, and in many cases the bridges are too weak to carry tractors. Many portions of the roads run through timber so that any effort to widen them necessitates much clearing.

Type of Tractor—Several designs of tractor were investigated, but the type finally selected was a combination kerosene-gasoline, 50-25-hp. tractor made by the Ohio Tractor Co., of Marion, Ohio, costing $3000. 25-15-hp. tractor was first received and tried out, bu drawbar pull was found too light for the heavy grades countered—often 8 to 10%—and, also, the loose of the river valleys made it impossible to move the tr with the extra weight put on the frame for rolling poses. As stated above, conditions in the South Atla States differ from conditions in the mid-Western pra sections, for which the gasoline tractor apparently was signed.

While the tractor developing 25 hp. on belt and 15 on drawbar pull met requirements as a roller and trac for light pulling, it was seen that there would be so lit rolling done and so much heavy pulling needed that 50-25-hp. engine would be more suited to the presen needs of the county. Developments have fully justifie the selection made.

The motor is an opposed-cylinder, heavy-duty type, burning kerosene in several grades, or gasoline. It has been found that more tractive power is developed on gasoline. While this costs more, it has been proved that 1 bbl. of gasoline will last as long as 1¼ bbl. of kerosene, as well as produce more power. The conditions being such that there is no way of telling what kind of work will develop during the day's progress it has seemed better to burn gasoline. The fuel tank holds a full barrel, which has lasted variously from 7 to 10 hr., running on heavy to light work.

Grubbing—Heretofore, grubbing has been done by hand labor. It was thought the tractor could be used for pulling the stumps, but after a few successful efforts the gears were badly smashed. Damage to gears amounting to $150 was made on a tree stump which could have been blown up with less than a dollar's worth of dynamite. It is still believed, however, that applying belt power to a windlass-rigged stump puller will prove successful.

Comparison of Cost with Mule Power—The tractor has been used in all traction work formerly done by mules, besides being used for some belt power, for which mules, of course, could not. The tractor regularly hauls in grading two large-sized Buckeye blade graders. These are of a much heavier type than is commonly used in the

*Surveyor, Box 61, Woodford, Caroline County, Va.

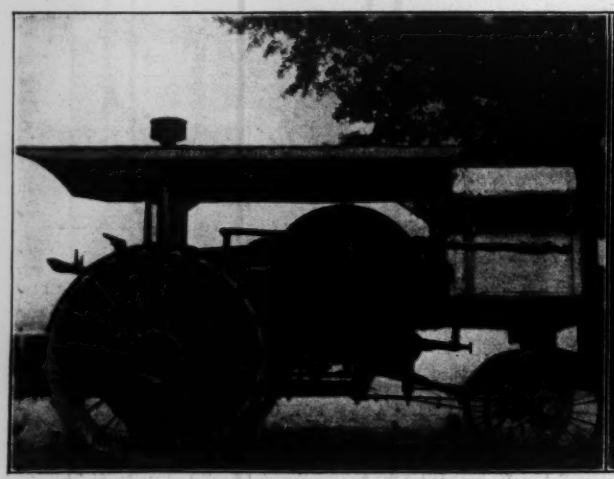


Fig. 1. Type of Gasoline Tractor Used by Caroline County, Va.

Fig. 2. Kind of Road Conditions; Tractor Climbing an 8% Grade

FIG. 3. TYPE OF BRIDGE WHICH MUST BE REPLACED WHERE TRACTORS ARE TO BE USED

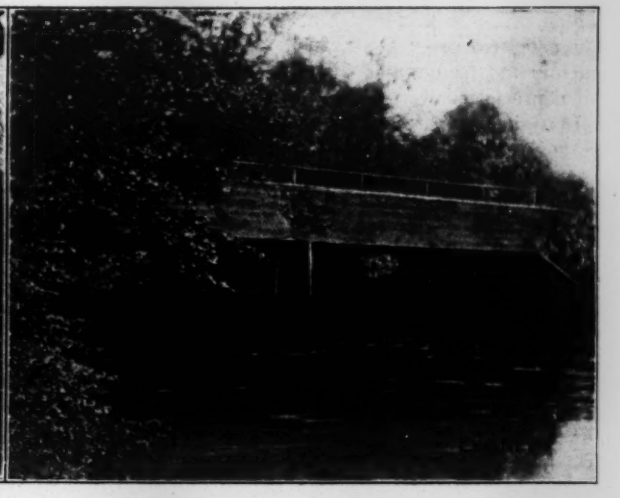


FIG. 4. NEW REINFORCED-CONCRETE BRIDGE; TWO 26-FT. SPANS; COST $2200

South, and to each six mules are regularly hitched. The graders are also set very much deeper than is possible for any mule team to handle. A cross-section area about 50% greater is cut by the tractor-drawn tool.

METHOD OF USING GRADERS—One grader is hitched with an angle coupling so that it runs in the ditch. The steering gear is locked to hold it in this way. This does away with the need for a steersman, who is needed on mule graders. The blade of this grader is sunk obliquely to the required depth, varying from 6 in. over the blade depth in soft land to a cut of about 12 in. in hard clay or packed gravel. There is practically no rock near the surface in this county. Gravel is used exclusively as surfacing material on improved roads.

The second grader is hitched to a double-length pole, so as to follow the first grader and catch the dirt thrown from the ditch and push it farther toward the crown. Usually this lands the earth dug from the ditches in the right place, and it is seldom necessary to make more than two trips over a section of road to bring the crown to the desired height.

Work has been done in which no less than ten trips of the mule-drawn graders were not equivalent to two trips of the tractor outfit. Another great advantage in using the tractor is that the angle hitch for the ditch grader allows the motive power to travel in the center and hard part of the road. Where the ditches are low and swampy, as much of the valley and low-lying roads in this section are, mules have frequently mired in the mud; or it was impossible to use machine graders at all, so ditches had to be dug by hand at great expense.

COMPARATIVE COSTS—There is some work tractors cannot profitably do, such as light hauling for patching ruts and filling from borrow pits with scrapers. In all other lines, however, this tractor has proved the economy of motor power over mule power.

It is, of course, difficult to arrive at a definite cost price per cubic yard for moving dirt from ditch to crown in road-grading work. But as close a calculation as it has been possible to make indicates that this tractor has moved such earth, in a particularly easy situation for mules, for 2.8c. per cu.yd. By mule power the cost has been 3.2c.

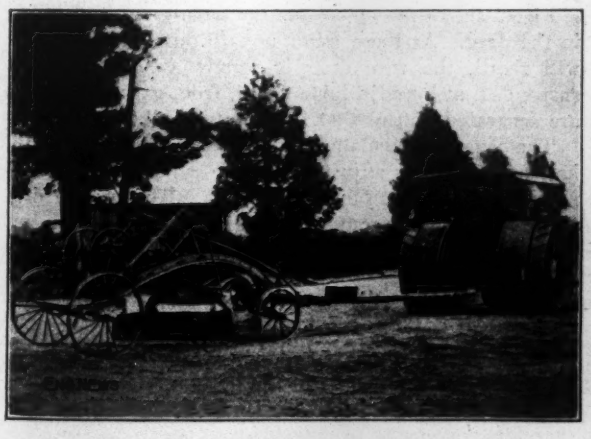


FIG. 5. GRADER AND TRACTOR OUTFIT

FIG. 6. ROAD GRADED WITH TRACTOR AND GRADERS

per cu.yd., which indicates a saving of 0.4c. per cu.yd. These figures cover labor, fuel, lubricating oil, etc., for tractor, and feed, stable costs, labor, etc., for mules, but not depreciation charges.

Inasmuch as this work was especially easy for mules, being in good dry ditches, with no stumps and moderately soft soil, the mule cost will show more favorably than a seasonal average, in which mules were called upon to perform all kinds of work.

Especially on the unusually steep grades, which the rather backward road administration has permitted, the mule cost will climb. I believe it safe to say that were a seasonal average computed it would show a saving of at least 1c. per cu.yd. in favor of the tractor.

Despite its newness to Southern road officials, and the consequent large amount of "lost motion" they required for experimenting, this tractor has moved at least 100,000 cu.yd. of road material in Caroline County in the past year, which would indicate a saving of $1000 over the same work done by mules.

The depreciation of the tractor may be figured at $800, while a maintenance account (not fuel or oil, but repairs, etc., to engine itself) of close to $400 has been incurred. However, the largest item of this was for breaks in gears resulting from stump-pulling and this, of course, had better be charged to "experiment" than *bona fide* maintenance.

It would seem that it has cost $1200 in overhead charges to operate the tractor for a season, but it has effected a saving of approximately $1000 in actual operation costs on grading. In addition to this should be mentioned the belt power supplied, and some hauling economy. On the whole, taking into consideration the fact that the tractor revolutionizes road work wherever it is introduced, and that some time is always needed to adapt the new apparatus to old conditions, the evidence is all in favor of the gasoline tractor's economy.

Irrigation by Pumping Underground Waters in Nevada—The reclamation of land by irrigation with water pumped from underground sources has large possibilities in Nevada, according to a report on "Irrigation Pumping" (1913) by Charles A. Norcross, State Commission of Industry, Agriculture and Irrigation. The report states that about 18,000,000 acres of valley lands are capable of cultivation where water for irrigation is provided, but at present only about 850,000 acres are under cultivation, practically all reclaimed by means of surface waters. The total reclamation possible by the storage of flood waters does not exceed about 8% of the total, but Mr. Norcross states that underneath large areas of the arable lands there are underground waters (at depth from a few feet to 1000 ft.) conserved in gravel and sand strata. In the deeper strata the artesian pressure may force the water in wells to the surface or to within reach of pumps. His report deals with lifts up to 50 ft., but states that lifts of 75 to 100 ft. are within the limits of economic working for certain classes of high-priced crops.

There were probably about 50 irrigation pumping plants operating in Nevada in 1913 most of these being recent installations. During the year about a dozen electrically operated pumps were put in service in Washoe, Eagle and Carson valleys, in western Nevada. The largest has a 12-in. direct-connected horizontal centrifugal pump operated by a 50-hp. motor, the lift being 37 ft. It has sufficient capacity to supply 3 acre-ft. of water during the irrigation season for 500 acres (200 of which have been put under cultivation), and this amount is sufficient for this particular land. Where electricity is available the cost is 1.2 to 1.7c. per kw.-hr. equivalent to $7 per hp. per month. Gasoline at 25c. per gal. would cost about $22.50 per hp. per month, and crude oil $17.50 where the pump owner can handle it in carload lots. Distillate costs materially less than gasoline and the consumption per hp. is about 12½% greater. Wood or coal would cost about $12 or $10.50 per hp. per month.

Recent Improvements in the Wire Drag Used by the United States Coast Survey; Its Possible Use as a War Machine

The long wire drag or sweep as developed and used by the United States Coast and Geodetic Survey in hydrographic surveying was quite fully described in ENGINEERING NEWS of Dec. 1, 1910, as most of our readers will probably recall. Since then several improvements have been made in its manipulation, which add much both to its effectiveness and efficiency.

Three wire drag parties are now at work on the coasts of the United States, one near Portland, Me., one on Buzzards Bay and the other on the West coast in Alaska. The importance of this work in effectively and finally verifying charted depths and in discovering uncharted shoals and menaces to navigation is being more fully appreciated, and Congress is even now being urged to make a special appropriation of $200,000 for work in Alaska, where too frequent shipwrecks on uncharted rocks have shown the inadequacy of the ordinary sounding method on a rocky bottom.

The accompanying illustrations show the present method of handling a wire drag 6000 to 14,000 ft. long. The drag—longer, heavier and stronger than that formerly used—requires larger and more powerful towing boats. The boat shown is a gasoline power tug, about 70 ft. long and 15 ft. beam, especially rigged for a season's work.

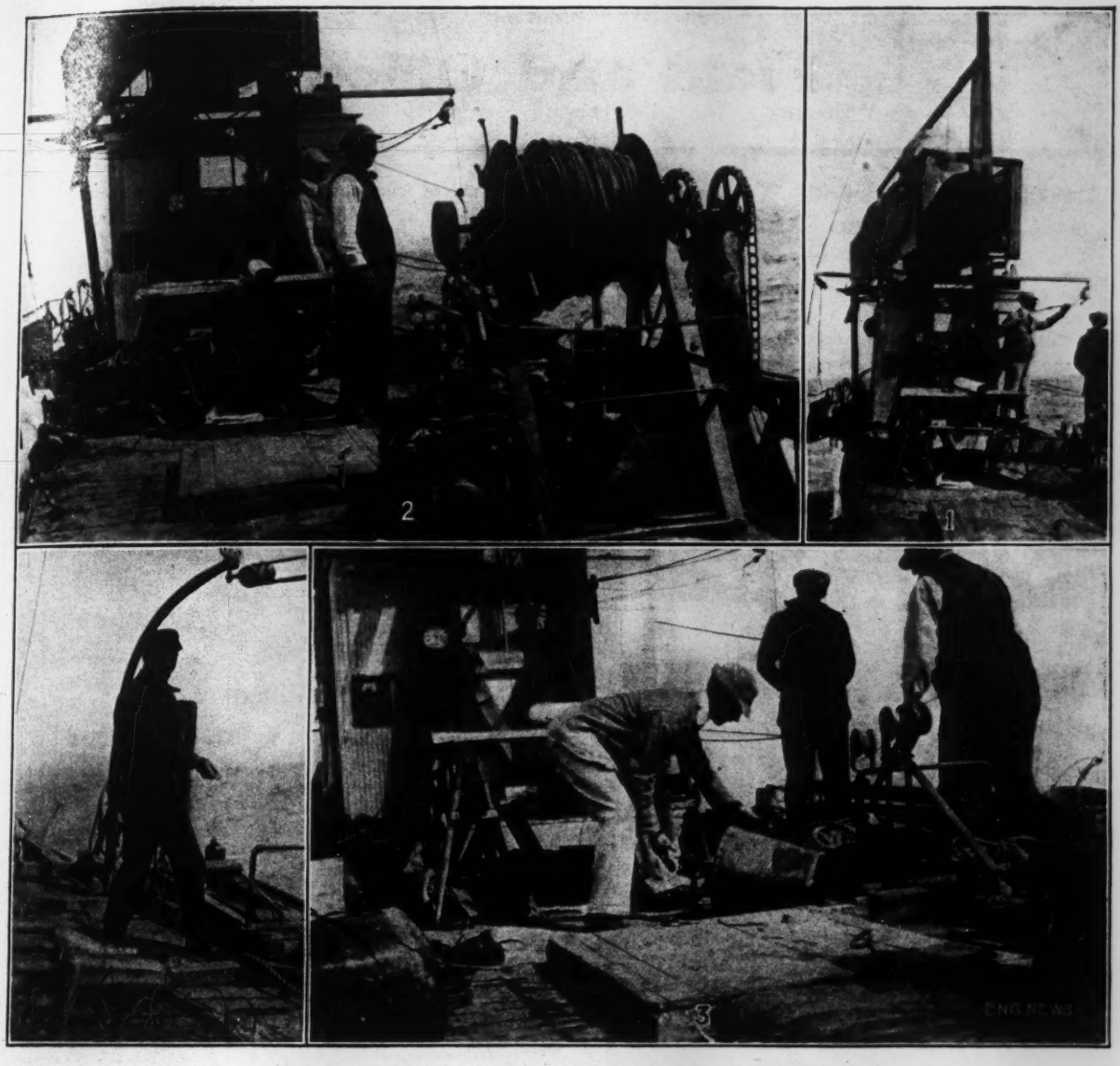
The necessity for frequent communication between the towing boats, which may be a mile or two miles apart, led to the development of the signal system shown in Fig. 1, consisting of three cloth-covered balls, red, blue and white, operated by levers behind the drafting table. The black ball in front is raised and dropped on the hour as a time signal, so that the clock and watches of both boats may be set to the same time. These four balls are mounted on a bridge framework, which can be swung so that its broadside is always toward the other boat.

The ball signal system is supplemented by the U. S. Navy wigwag system of hand flag signals, which permits any kind of a message. The party is now experimenting with wireless telegraphy as a means of drag control. Fig. 1 also shows the drafting table and equipment. The progress of the drag is plotted as the work proceeds.

Fig. 2 shows the apparatus for setting out and taking in the drag. As those familiar with our previous article will recall, the wire drag is merely a horizontal wire suspended, at an adjustable depth, from can buoys which are separated 150 or 300 ft. longitudinally.

The length of the upright wires, or the depth of the horizontal wire, is adjustable to the depth to be verified, making proper allowance for a tide. Towing the drag from each end, of course, sweeps a strip of bottom and any projection catches and holds the bottom horizontal wire.

The horizontal wire is held down and kept horizontal by iron ball weights attached to the buoy uprights. The two ends of the drag are fastened to large towing buoys. Wood floats are attached to the bottom wire at intervals between the buoy uprights. In reeling the drag it is, therefore, necessary to detach buoys, floats and weights, as well as wind up a mile or two of wire, besides the buoy



WIRE DRAG WORK OF THE UNITED STATES COAST SURVEY

Fig. 1. Signal system on leading towboat. Fig. 2 and Fig. 3. Taking in drag with power reel. Fig. 4. Taking off weights, buoys, etc., on bow.

uprights, the wire parts of which remain attached to the bottom wire.

To drive the reel a 2½-hp. gasoline motor is provided. The control of the engine and reel is by levers, handled by the man in the middle of Fig. 3. In Fig. 3 is also shown a pulley device, moved back and forth horizontally by a power-driven cam, to distribute the wire on the reel. Practically the only actual handling of the drag is done by the man on the bow, Fig. 4, who detaches the weights, floats and buoys. He is safeguarded from the incoming wire and attachments by a rope netting.

Obviously the longer the drag the more efficient the work may be done, dependent, of course, on local conditions. The longer drag would not have been possible except by the introduction of methods of mechanical manipulation. With mechanical handling the various safeguards mentioned were essential to the prevention of accidents, especially in reeling in the drag.

It may be interesting to our readers, in view of the great naval battles which are being fought, or are about to be fought in the European War, to know that it is possible to turn the wire drag into a very effective machine for finding out and destroying mines intended to blow up warships. In dragging the coast off New London, Conn., two or three years ago, several practice mines, planted by forces in the mimic war then in progress, were unearthed, and occasionally brought to the surface, by the wire-drag party under N. H. Heck, Assistant, Coast and Geodetic Survey, who is chiefly responsible for the wire drag as it now exists.

Automobile Exports from the United States in the fiscal year ending June 30, 1914, were valued at $40,136,565, as compared with $39,325,000 for 1913, the latter being the highest on record before this year Nearly half of the automobile exports were sent to Europe. Imports of automobiles in the year 1914 were only 300 cars valued at about $620,000, as compared with 1624 cars valued at nearly $3,000,000 in 1909.

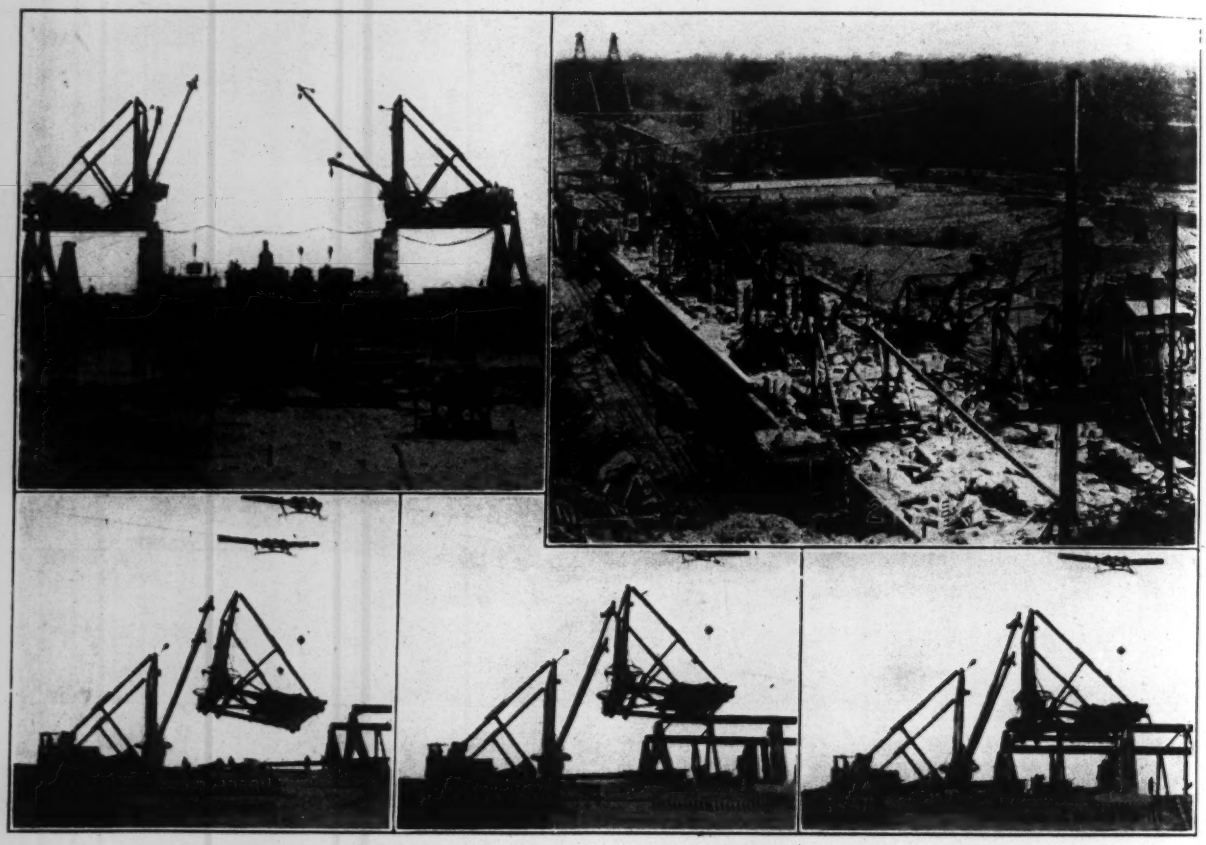
Field and Office

Shifting Derrick Travelers, Kensico Dam

By Wilson Fitch Smith*

The masonry construction of Kensico Dam, now being built by the City of New York, as a part of the Catskill Water Supply System, was described in an article published in Engineering News, May 21, 1914. Briefly the masonry is being placed by a number of stiff-leg derricks mounted in pairs on travelers. The travelers are carried on elevated tracks supported on masonry piers 25 ft. high (Fig. 1). In the lower portions of the dam, there were two parallel traveler tracks running the length of the dam, and the travelers were arranged in pairs, facing each other on each track, so that four travelers or eight derricks covered each section of the dam between expansion joints, which are about 80 ft. apart (Fig. 2). The tracks permit the travelers to be readily moved from one section to another as the masonry is completed up to the elevation of the tracks. Above 242, at which the width of the dam is 106 ft., but a single traveler track is used, carrying six travelers permitting three sections to be built simultaneously. The end sections of the dam joining the hillsides are constructed by guy derricks.

The raising of these travelers to the new elevated tracks as each succeeding lift of the dam is completed is an interesting operation.



Figs. 1-5. Shifting Travelers from Lower to Upper Lift, Kensico Dam

(Fig. 1. Two travelers working on lower lift. Fig. 2. Looking over Kensico dam, showing parallel traveler service in foreground and single travelers in background. Figs. 3-5. Stages in lifting right-hand traveler.)

The travelers are heavy, braced timber frames 30 ft. wide and 39 ft. long, each carrying two stiff-leg derricks with 57-ft. booms operated by double-speed, 75-hp. electric hoists. Fully equipped with counterweights, each traveler weighs about 100 tons. The traveler track consists of two rails 30 ft. apart, each carried on a line of stringers formed of 28-in. Bethlehem H-beams, 39.5 ft. long. Two spans just cover a section between expansion joints, so that the stringers are alternately supported on portions of the expansion-joint facing built up

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of concrete blocks to form piers 25 ft. high in advance of the rest of the joint facing, and on removable framed timber pedestals in the center of each section between the expansion joints; thus obviating entirely the concrete piers used in the lower portion of the dam which were so conspicuous a part of last year's work. This present arrangement is shown in Fig. 1.

After the masonry is completed up to the elevation of the traveler track in several adjoining sections, the expansion-joint-block piers are erected for the new level and the tracks put in place. On the completion of the masonry in the last section allotted to any pair of travelers, one traveler is dismantled by removing the hoist, booms and the counterweights, which are regular concrete blocks used in the expansion-joint facing. This work is done by the cableways and reduces the weight of the traveler to about 48 tons. Then the two cableway hoists are attached to the back end of the traveler by a running bridle and the two derricks of the companion traveler are attached to the front end of the traveler. By concerted action, the traveler is lifted to the elevation of the new tracks (Fig. 3). The cableways are then moved so that the suspended load is drawn over the new tracks (Fig. 4) and guided by the derricks the traveler is carefully lowered onto the new tracks. This traveler is then re-equipped and the other dismantled, and the operation repeated, the upper traveler now helping the lower one to its new position.

The last change, the one illustrated, required less than seven minutes to lift the traveler from rail to rail, and the elapsed time for the complete change from the last masonry placed by these derricks on the lower level to the first placed on the new level was 24 hours, the work being conducted only in daylight hours. As far as possible these shifts are made on Sunday. Fig. 2 is a general view of the dam from the west hill, showing the upstream face. In the foreground four travelers are completing a section to Elev. 242. To the left the single traveler track is erected at Elev. 264.5, and one pair of travelers are being lifted to the new track, as described in this article, while at the farther end of the dam masonry is being placed in a section above Elev. 242.

The dam is being built under the direction of the Board of Water Supply of the City of New York, by H. S. Kerbaugh, Inc.

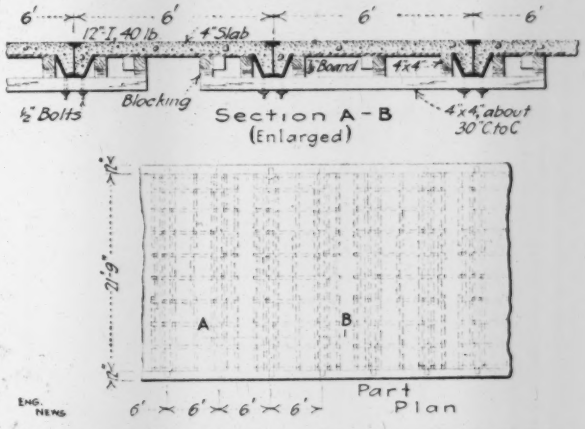
Forms for Concrete-Incased I-Beam Floor

By M. J. Lorente*

In the construction of a private residence of reinforced concrete at Grosse Pointe Farms, Mich., the writer used for one of the floors—a concrete slab with concrete-incased I-beams—a special type of form which was dictated by certain local conditions, but which should prove economical for similar floor designs. A detail of the formwork is given in the accompanying cut.

The main portion of the floor, comprising close to 4000 sq.ft., is supported on 12-in. 40-lb. I-beams, spaced from 6 ft. to 7 ft. 6 in. on centers. The material available on the job for the forms was a large quantity of 4x4-in. timbers ranging in length from 8 to 13 ft., and a considerable amount of ⅞-in. sheathing, all of which had previously been used.

The 4x4-in. timbers were in excellent condition, but the sheathing was in pretty bad shape, owing to its poor quality and to the rough handling it had met. So



Details of Formwork for Concrete Floor with I-Beam Stringers

bad was its condition that very little was sound for a greater length than 7 ft. Such being the case, and as the sheathing could be of no further use after the second floor, the writer decided to put up the forms in such a way as to preserve the 4x4-in. timbers as much as possible and to cut only the sheathing.

A set of 4x4-in. timbers had two holes bored near each end, so that they could be secured tightly by two ½-in. bolts to the lower flanges of two adjacent beams, leaving an overhang of about 1 ft. 6 in. at either end. The bolts were bent to fit the flanges of the beams but were not flattened, as is commonly the case. On these cross-timbers were placed other 4x4-in. timbers running parallel with the beams and brought up to the desired height by blocking underneath. Two lines of these longitudinal timbers were placed the proper distance from the beams to allow for the haunches, and another line was placed in or near the middle of the panel. On these timbers was nailed the sheathing, which had to be cut the same length as the clear distance between the top of the haunches. The bevel was formed by sheathing resting on the edge of the beam flanges and the top edge of the longitudinal timbers close to the beams.

The cross timbers were bolted only in alternate panels. In the other panels four lines, instead of three, of longitudinal timbers were used, two close to the beams and two along the ends projecting from the cross-timbers in the adjacent panels. When the exact length could not be made up, the longitudinal timbers were placed side by side so as to avoid cutting. With the timbers close to the beams, cutting was imperative in a few cases, as the timbers had to be in line in order to provide a straight bearing for the boards forming the haunches.

Ribbed Glass to Prevent Drip at Skylights—The elimination of condensation drip from the underside of skylights is claimed to be effected by the use of ribbed or corrugated glass. A special glass for this purpose, with eight ribs or convolutions per inch, has just been put on the market by the Pennsylvania Wire Glass Co., Pennsylvania Building, Philadelphia, Penn., and called "Aqueduct" glass. It is ¼-in. thick, and wired. This ribbing is claimed to have the maximum capillary action.

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An Interesting Method for Railway Rechaining

In rechaining the Cleveland Short Line Ry., a unique method was employed. The total distance from Collinwood, where this double-track belt line leaves the L. S. & M. S. Ry., east of Cleveland, to the junction with the same line at Rockport, west of the city, including wye connections with the C. C. C. & St. L., B. & O., and Lake Shore, is 23 miles. Following the standard practice of the Lake Shore, the base line was measured along the center line of the westbound main track.

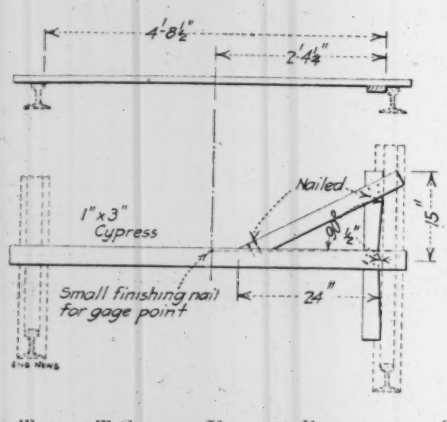

FIG. 1. TRACK T-SQUARE USED IN RECHAINING CLEVELAND SHORT LINE RY.

The equipment consisted of a 100-ft. steel tape (correct at 70° F. with 16-lb. pull, tape supported at the ends; spring balance at the head end, temperature scale and thermometer on the rear end), a steel brush for cleaning the rail, and two T-squares made of 1x3-in. cypress. These T-squares (Fig. 1) were the special feature of the method of rechaining. The work was carried on intermittently as other work permitted, by the regular field party engaged on construction on the Short Line: assistant engineer, instrumentman and two rodmen. Each station number was painted on the rail, using white-lead-and-oil, so that the work of making a complete resurvey of the line might be facilitated. No pluses were taken other than marking on the rail the location of mile posts.

In operation, one of the rodmen acted as rear chain, and the other handled the T-square at that end; the instrumentman and assistant engineer worked in similar positions at the head end. At the beginning, one T-square, coinciding with the zero station, was held firmly against the rail and watched to prevent any motion while the measurement was being made. The other T-square, placed in approximate position while the head chain was getting into position to make the measurement, was jarred back or ahead a little as the tension was being applied by means of the balance, until the small finishing nail centered in the notch at the 100-ft. point on the tape. Then the head chain reached over and made a line with a slate pencil across the head of the rail along the side of the T-square, held firmly in place by the assistant engineer.

As soon as tension slacked, the man handling the rear T-square brought it quickly to the head chain, who started with it to the next station. The assistant engineer, with pot and brush, painted a line down the side of the rail, and painted the station number on the base in figures as large as the width of the base of rail permitted. The station was checked by having the rear chain call out the number of the one he had just set. As an extra precaution against error, everyone in the party carried the station in mind. By carrying the rear T-square ahead and leaving the head one in place for the rear chain to use, any error due to resetting was eliminated.

It was the intention originally to measure with the tape flat on top of the rail on tangents and to use the T-squares on curves only. But on the day the rechaining was begun, considerable difficulty was experienced in getting the tape to lie flat on top of the rail on the first tangent, on account of a high wind. After the first curve had been passed, the use of the T-squares was continued as an experiment on the tangent; so much better progress was made than on the first tangent, that they were used for the balance of the work. Their continual use gave also a uniform unit of measurement, for the reason that the tape was in suspension at all times and under uniform conditions of pull, instead of supported on tangent and suspended on curves.

RAPIDITY AND COST

No very definite figures as to number of miles to be chained in a day, or cost per mile, can be given, for the reason that the work was done intermittently. On the basis of an 8-hr. day, an average of 2 hr. of which was consumed in going to and from the work, about 4.5 mi. per day was covered. This average may be regarded as a minimum, inasmuch as a considerable quantity of ballast freshly distributed had to be dug through to lay bare the base of rail for painting station numbers.

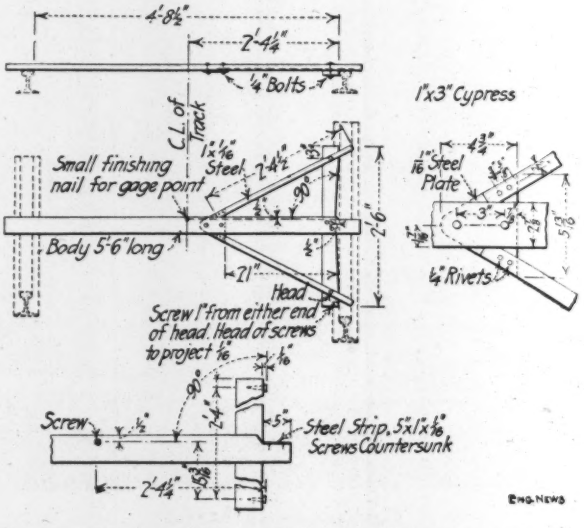

FIG. 2. IMPROVED TRACK T-SQUARE, DESIGNED FOR RECHAINING A LONG RAILWAY LINE

The cost of the work averaged about $3.25 per mile, and included only salaries of the four men. On a more extensive job, expenses of the party would be included, but such increase would be somewhat balanced by the employment of lower-salaried men.

Accuracy

At the west end of the line, an opportunity was had to compare the T-square method with 9 mi. of base-line chaining which had been done previously with considerable precision, using tripods carrying knife-edges as a part of the equipment. By the tripod method, 1000 ft. was checked back with a permissible variation of 0.01 ft. The difference between the T-square and tripod methods on the 9 mi. was 0.27 ft., or 0.03 ft. per mile.

If a considerable amount of accurate track chaining is required to be done, especially where a fairly high percentage of curvature exists in the alignment, or where the work must be done during the inclement months, the T-square method has advantages apparent to anyone who has chained center line over stone ballast, or through snow and slush. It could be employed to take pluses where objects lying a considerable distance from the track are to be located closely, for instance, in chain surveys of yards and stations. The general custom of taking a plus to a half foot, when the point in the track from which the object bears at right angles is determined by sighting along a tie or by swinging the arms, is of doubtful propriety.

The T-squares used in the rechaining of the Short Line, Fig. 1, were made by a rodman, using material at hand and with as little expenditure of time as necessary, for the reason that the method was considered of doubtful utility and at the most applicable to curves. Since it proved on trial quite economical when degree of accuracy is considered, it might be worth while to make a more substantial tool after the manner of Fig. 2. A good patternmaker would charge about $7 for each.

For information concerning the method of rechaining, we are indebted to John F. Schwed, Office Engineer with the Chief Engineer of the Wheeling & Lake Erie Ry., who was in charge of the rechaining on the Cleveland Short Line. Fig. 2 is a design made by a railroad engineer in anticipation of a large rechaining job.

A Novel Circular Computer

A computing device, based on the principle of the slide-rule, is shown in the accompanying illustration. This computer is claimed to be more accurate than a 20-in. slide-rule, yet possesses an advantage over the regulation slide-rule in being more easily read and operated, and in having a scale for the addition and subtraction of numbers. The graduation is also unique, and much more legible than that of the standard slide-rule scale.

The device consists of a metal frame, to which is fixed a ring plate *B*, a revolving metal disk *A*, about 10 in. in diameter, with two rows of graduations (shown at *C*), the outer a logarithmic scale like that of a slide-rule for operations of multiplication and division, and an inner scale of equal division for addition and subtraction. The figures and divisions of the logarithmic scale are black and of the number scale red. As the main divisions on these disk *A* scales would be hidden at the point where they are read *C*, they are placed outside of the ring plate *B*, where they are always in view. On the fixed ring plate *B* there are exactly similar scales and divisions.

The procedure in using the computer is as follows: With the handle *E* pressed down, revolve the disk *A* until the number to be multiplied (or added to) appears at the index *C*. Lift the knob *E*, raising which clamps the lower plate at the index reading. With the handle still raised turn the arm *D* to the multiplier (or number to be added) on the ring *B* scale. When *D* is set, press down the knob *E*, in which position it clamps the arm *D* on its-

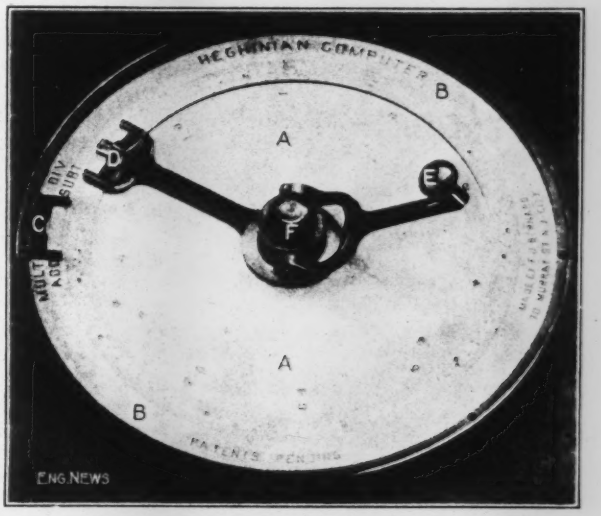

Fig. 1. Calculating Device Invented by G. G. Heghinian of Brooklyn, N. Y.

reading and unclamps the movement of the lower disk *A*. Now move the arm index *D* by revolving the lower disk *A* to the hair line of index *C*, and we read on the scale at *C* the desired result. If the result is to be divided by any number, instead of moving *D* to the index, move it to this number, and the final result appears at the index at *C*.

In the illustration the index slide *D* is shown set on the logarithmic scale and the index slide *C* on the number scale. These slides cover the scale not in use and thus avoid confusion. Slide *D* is shown equipped with a semi-cylindrical magnifying glass.

The operations of subtraction and division are, of course, the reverse of the process given for multiplication and addition. The result is always read at the index *C*.

Fig. 2 shows some of the details of construction of the computer, which is made throughout of metal, the plates being silver plated. The system of graduation was devised for this computer and makes the close reading of the scale particularly easy. The head *F*, Fig. 1, contains a spiral spring, as shown in the cross-section, Fig. 2,

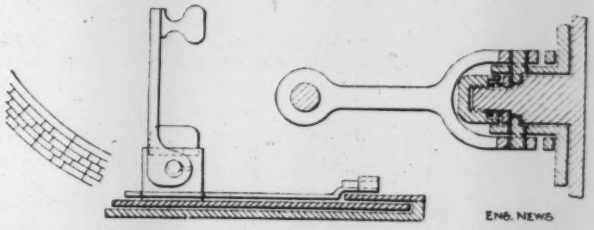

Fig. 2. Structural Parts of the Heghinian Computer

which prevents the binding of the plates and takes up any wear on the cam by which the clamping of the plates is accomplished.

The device is called the Heghinian Computer and is

the invention of Garabed G. Heghinian, a civil-engineer graduate of the Massachusetts Institute of Technology, who is a consulting asphalt expert, at 407 Hamilton Avenue, Brooklyn, N. Y. The maker is F. J. Bernard, 75 Murray St., New York City, and the instrument is made to sell for about $35.

Settlement of a Pile Foundation

A bad case of foundation failure is illustrated by the accompanying views, showing parts of two newly completed brick apartment houses on Elsmere Place, near the Southern Boulevard, the Bronx, New York City. These buildings were founded on wood piles, as the ground is marshy for a depth of 25 to 40 ft. down to rock. Short piles were used, not driven to rock, and under the load of the completed buildings they settled, causing the walls to crack as shown.

Engineers who examined the case for the mason contractor found that all the piles they uncovered could be driven at least two feet farther down before stopping at hard bottom, and that the soil was not good for more than ¾ ton per sq.ft. Beyond this fact and the known depth to rock the character of the old pile foundation is not known in detail as there was no inspection. The piling plan of the architect (J. Fred Pelham, New York City) shows a double line of staggered piles placed 18 in. c. to c. under all walls; but this was not strictly followed as the presence of large boulders at the front of the site, necessitated a certain amount of excavation here and the placing of concrete foundations. This explains why the settlement of the buildings was not more general.

CRACKED WALLS DUE TO FOUNDATION SETTLEMENT

Cribwork floats shown. Wood beams which span windows carry steel cables tied across inside.

To restore the buildings, tubular steel piles were put down under the settled portion of the wall. To prevent the possible collapse of the walls, steel cables were tied across inside the buildings at all cracked sections and drawn tight. In the case of one of the buildings, which was in worse condition than the other, timber floats of cribwork construction were placed in the cellar and in the back yard, connected by steel beams which pierced the masonry. As this shoring settled under the load of

the settled portion of the building, the cribwork was jacked up until firm bearing was secured.

Part of the new steel piling is 12-in., driven with a steam hammer; the remainder of the piles are 9-in., forced down by jacking against the weight of the wall. Sections of the wall were broken out to admit the new piles, which were driven to refusal, blown out with air, reinforcing-rods placed in them, and the tubes filled with concrete. In all, about 80 of these piles were put down along the wall, designed to carry a load of about three tons each.

At the time the buildings were erected, only occasional inspection was given to the piledriving, according to the usual practice of the building bureau. At present, however, the Bronx buildings bureau inspects all piling jobs by keeping an inspector on the job steadily until the piledriving is finished. However, Henry Morehead, Superintendent of the bureau (but not in office at the time these two apartment houses were constructed) says that he considers it an outrage that this should be necessary.

There was no general contractor on this work; contracts for the several elements were let by the owner under the name of the Defender Construction Co.

The Error in Design of Columns for Bending

By J. P. J. Williams*

Columns subjected to bending moment in addition to direct axial compression, are usually designed by an approximate method, which neglects the effect of deflection upon the value of the bending moment. Formulas and diagrams based upon this approximate method by which required areas can be found were given by Mr. Paaswell, in the Engineering News of June 26, 1913, p. 1333. It will now be shown that a relatively simple formula can be used to obtain the error or correction to be applied to the approximate value of the area to obtain the true area required. The percentage of error resulting from the use of the approximate formula is then easily noted.

Let

A = Total required area of column by the approximate formula (or diagrams);
A_e = Same area as obtained by more exact formula;
$A_c = A_e - A$ = error or correction to be applied to A;
P = Total direct axial stress in pounds;
M = Maximum bending moment in pound-inches;
h = Depth of column in direction of bending;
r = Radius of gyration about an axis perpendicular to the plane of bending;
s = Allowable unit-stress by column formula;
l = Unsupported length of column in inches;
E = Coefficient of elasticity in pounds per square inch;
k = Constant depending upon end conditions (= 32 for fixed ends; 10 for pin ends; 24 for one fixed, one pin end.)

Also, let $\frac{M\left(\frac{h}{2}\right)}{r^2}$ be called P_b, and $\frac{P\left(\frac{l}{r}\right)^2}{k\,EA}$ be called K.

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The approximate formula generally used can then be given in the following form:

$$A = \frac{P}{s} + \frac{Mh}{2r^2 s} = \frac{P + P_b}{s}$$

As developed in standard textbooks on the subject, the more exact formula for total stress s is:

$$s = \frac{P}{A_e} + \frac{\frac{1}{2}Mh}{I - Pl^2/kE}$$

By substituting $A_e r^2$ for I, and assuming for practical purposes that $\frac{A_e}{A} = 1$ in the second term of the second denominator, the value of A_e is found to be:

$$A_e = \frac{P + \frac{M\left(\frac{h}{2}\right)}{r^2 - \frac{Pl^2}{kEA}}}{s} = \frac{P + \frac{M\left(\frac{h}{2}\right)}{r^2\left(1 - \frac{Pl^2}{kEAr^2}\right)}}{s}$$

$$= \frac{P + \frac{P_b}{1 - K}}{s}$$

Therefore

$$A_c = A_e - A = \frac{\frac{P_b}{1-K} - P_b}{s} = \left(\frac{K}{1-K}\right)\frac{P_b}{s}$$

This A_c is the error on the side of danger when columns are designed by the approximate formula

$$A = \frac{P}{s} + \frac{Mh}{2r^2 s}.$$

In most cases the error is only a very small percentage of area A. But the error varies directly with K and with P_b, and therefore increases with increased slenderness $\left(\frac{l}{r}\right)$ and increased bending moment.

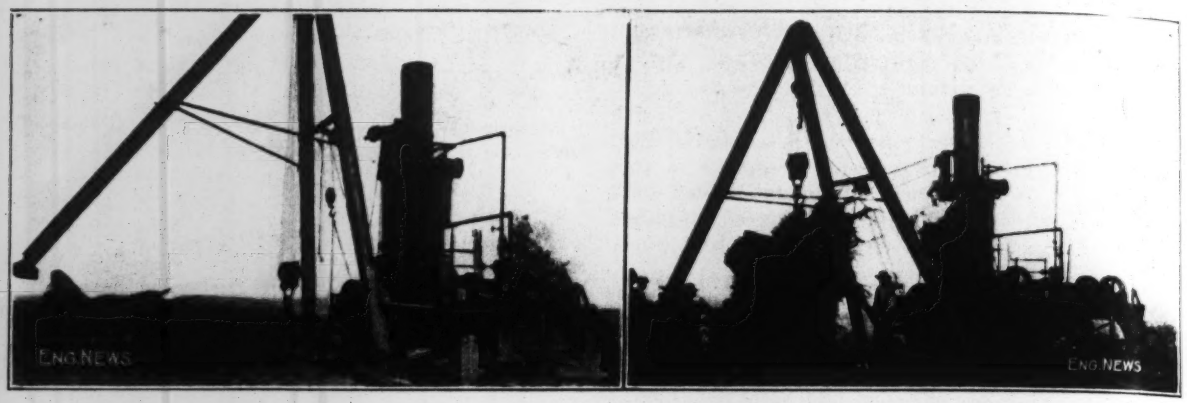
Procedure—In designing columns with the use of the foregoing, proceed as follows: Assume depth h, obtain r by approximate ratio (see Engineering News, May 23, 1912, p. 991), compute $P_b = \frac{Mh}{2r^2}$, and then $A = \frac{P+P_b}{s}$. Next compute $K = \frac{P}{kEA}\left(\frac{l}{r}\right)^2$, and finally A_c, and determine the percentage of error.

Stump Pulling and Grubbing Machine

In the clearing and development of large tracts of land, the grubbing and removal of stumps quickly and economically is a problem, for modern conditions do not favor the old practice of leaving the stumps to rot or to be burned and pulled out piecemeal as the farmer can find time for such work.

There is a large field for machines which can do this work effectively at low cost, and the accompanying cut shows a machine which has been designed for this class of work. It is self-propelling, while light enough to travel over soft ground. It is designed to grub out the smaller stumps as well as to pull the large stumps, thus doing the entire work of clearing rapidly and at reasonable cost.

The machine consists of two parts, the tractor (with



STUMP-PULLING AND GRUBBING MACHINE FOR CLEARING LAND

hoisting engine) and the hoisting tripod. When at work, the latter rests on shoes on the ground, and is entirely free from the tractor. For moving from stump to stump, the tripod is tilted and raised so as to be carried clear of the ground by the tractor. The tractor has a 20-hp. horizontal engine and a vertical boiler. The engine is geared through a suitable clutch to the traction mechanism driving the rear wheels. For hoisting, the power is applied to two drums mounted on the front end of the frame, geared to give a powerful pull. For raising and lowering the tripod there is an auxiliary drum mounted on the gallows frame at the side of the machine.

The tractor is 18 ft. long and 8 ft. 3 in. wide over the frame, with a wheel base of 13 ft., and a weight of about 18,750 lb., exclusive of tripod. The rear wheels are 5 ft. in diameter, with 12-in. tires; the front wheels are 38 in. in diameter, with 8-in. tires.

The tripod is of 9-in. steel tube (33.9 lb. per ft.), with legs 24 ft. long and a spread of 18 ft. at the shoes, giving a working height of 19 ft. The legs are connected to a heavy cast-steel cap, to which is attached a loop or stirrup for the hoisting block. The two legs adjacent to the machine are connected by riveted braces, and the third leg when set out is held by hook-end braces fitted to lugs, as shown. For transportation, these latter braces are removed and the outstanding leg is folded in between the others. Each leg has a swivel foot, fitted with a shoe giving a large bearing area of support, the swivel permitting the shoe to adjust itself to the ground. The weight of the tripod, including block and tackle, is about 4000 lb.

In designing the tripod it was estimated that the maximum stress, or lift, would not exceed 70 tons, and the tripod was designed to withstand such a pull. The allowable load on 8-in. 28-lb. pipe used as a column, 24 ft. in length, is 40 tons, by the New York City building regulations, and the same figure for 10-in., 40-lb. pipe is 63.43 tons. As the load given is based on a liberal factor of safety, which is not necessary for a machine like the stump puller, the designers estimated that 9-in. pipe would be more than sufficient for any possible load in pulling a stump, even though the pull may come very largely on one leg, as is often the case. It is estimated that in practice, the pull will not exceed 40 tons in lifting a stump 48 in. in diameter. The fittings of the tripod are all steel castings, and designed with ample strength for the 70-tons pull mentioned above.

The wire rope from one of the drums leads to a pair of blocks suspended from the cap of the tripod, and the necessary power can be obtained by varying the number and arrangement of the sheaves. It is stated that a pull of about 45 tons, which is easily within the capacity of the machine using a pair of 5-sheave blocks, is ample for pulling stumps up to 4 ft. diameter. After the stump is pulled, it is the work of a few moments to lift the tripod, move to the next stump, and drop the tripod into position again. It is only necessary to use the tripod for stumps of the largest size, which are usually a small percentage of the total. All the lighter growth and smaller stumps are pulled by the ropes running forward directly from the drums.

For this lighter grubbing work, the machine uses ⅝-in. plow-steel ropes, about 250 ft. long. The engine is located where it can be anchored to a stump in the rear, and where a big stump ahead will serve to attach two head or guide blocks for the purpose of leading the ropes fairly onto the drums. Through these blocks the two ropes work simultaneously, covering a circle at one setting, amounting with the above length of rope to an area of over three acres. The drums give a direct pull of about 7 tons, which suffices for stumps up to 15 in. diameter. By doubling back through a single block, which involves but little loss of time, everything up to 20 in. diameter can be pulled. The comparatively light rope can be handled rapidly, which is very essential where there is much grubbing.

The tripod also affords a means of piling the stumps. For this operation, the rope is run through a block at the top of the tripod, and the tripod guyed to a stump in the rear. The stumps can then be skidded in (a higher speed on the drums being provided for this purpose), and they are readily dragged up into piles of considerable height.

This machine is being introduced by the Pioneer Land Clearing Machine Co., 1220 First National Bank Bldg., Chicago. On work in Ogemaw County, Michigan, the machine has pulled 200 stumps per day, the stumps ranging from 8 to 36-in. diameter.

A Model Town, known as Morgan Park, is being built within the city limits of Duluth by the Minnesota Steel Co. in connection with its new steel works at that city. It includes water-supply and sewerage systems, concrete paving for streets, and the erection of about 140 residences, besides a hospital, school, etc.

Traveling Car-Tipple on the Sag Canal

In the construction of the Chicago Drainage Canal a most important feature was the use of various forms of machinery for the removal of excavated material. One type of machine consisted of a traveling tipple or car dump, the cars on which received material from the steam shovel and dumped it to form a spoil bank at a suitable distance. Machines of this type have been used on other canal work, and are now being employed on part of the Sag Canal, which is an auxiliary channel extending from the Calumet River to the "Sag," a point on the Chicago main drainage canal. This Sag Canal was described in our issue of Jan. 23, 1913.

The new car tipple noted above is in use on contract section No. 9 of the canal work, 5500 ft. long. The cross-section here is 180 and 36 ft. top and bottom width, 37 ft. deep, with side slopes of 2 on 1, and 100 ft. width of berm. The rock lies at an average elevation of 10 to 12 ft. above the grade line of the bottom of the canal. The plan is to remove all the material above the rock in one cut, the steam shovel being placed in such position that it can take out the full section of the canal. It loads the material into two cars running on the incline of the tipple; each car holds two dipper loads, and while one car is being loaded the other is being dumped.

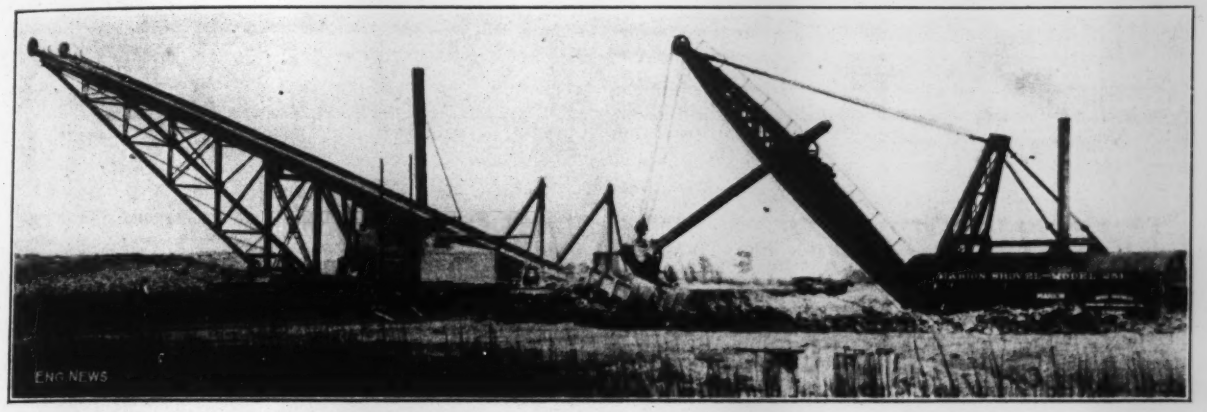


FIG. 1. TRAVELING CANTILEVER CAR TIPPLE ON THE SAG CANAL, CHICAGO, DELIVERING MATERIAL FROM STEAM SHOVEL TO FORM THE SPOIL BANK

The steam shovel is of the stripping type (ENGINEERING NEWS, Apr. 2, 1914), having a 75-ft. boom and 3½-yd. bucket; its upper part revolves on a main frame supported by four four-wheel trucks on two parallel tracks. Fig. 1 is a view of the entire plant, and shows the dipper about to deposit its contents in one of the two cars of the double-track incline or tipple.

The construction of the tipple is shown in Fig. 2. It consists mainly of two triangular trusses spaced 16 ft. c. to c., with the horizontal part of the bottom chords supported on two cross-frames. Each frame is carried by seven pairs of wheels on a standard-gage track, these tracks being 75 ft. apart, c. to c., laid parallel to the line of the cut, and the inner track being near the edge of the slope. The outer part of the structure forms a cantilever 80 ft. long, with its end about 60 ft. above the ground, and beyond its end projects the car-dumping platform. The boiler and machinery mounted on the deck serve to counterbalance the cantilever arm.

On this structure are laid two tracks, upon each of which runs a 7-yd. four-wheel car operated by a cable. To extend these tracks into the cut, so as to put the cars within the reach of the steam shovel, there is an apron 30 ft. long, hinged to the main frame and having at its lower end a 12x12-in. oak bolster which rests on the slope. Eyebars at the outer corners of the apron carry sheaves for tackle, led over masts on the main frame. Once a day the machine has to be moved forward about 30 ft., and the method of raising the apron during this movement is one of the special features of the new machine. The ends of the hoisting cables passing over the masts are attached to one of the dump cars. Then by hauling the car up the incline the apron is raised and held until the machine has been moved forward to its new position. As the steam shovel advances, the machine is moved forward by means of a hauling tackle and blocks, one block being hitched to an anchor or deadman.

At the upper end of the cantilever each track has a pivoted dumping platform 16 ft. long, the outer end of which carries the 5-ft. sheave for the car cable. The ends of the track rails are curved upward so as to embrace half the diameter of the front wheels of the car, thus holding the car firmly upon the track. To the tail end of the platform is attached a cable leading to a pendulum counterweight suspended in the truss.

As the loaded car runs upon the tilting platform, stirrups at the rear engage with dogs on the platform so as to hold the car in place. When it runs against the curved stop rails it automatically trips a latch which holds the platform, and the continued pull of the hoisting cable (together with the weight of the car) causes the platform to tilt on its horizontal shaft to the position shown by the dotted lines. The counterweight at the same time is raised to horizontal position, as shown, its effect increasing as the tipple is being revolved. The hoisting cable being slackened, the counterweight overcomes the weight of the empty car, and pulls the platform to its normal position. Fig. 3 shows the platform in the dumping position.

The equipment includes a 100-hp. horizontal boiler and a hoisting engine with cylinders 10½x12 in. The drums

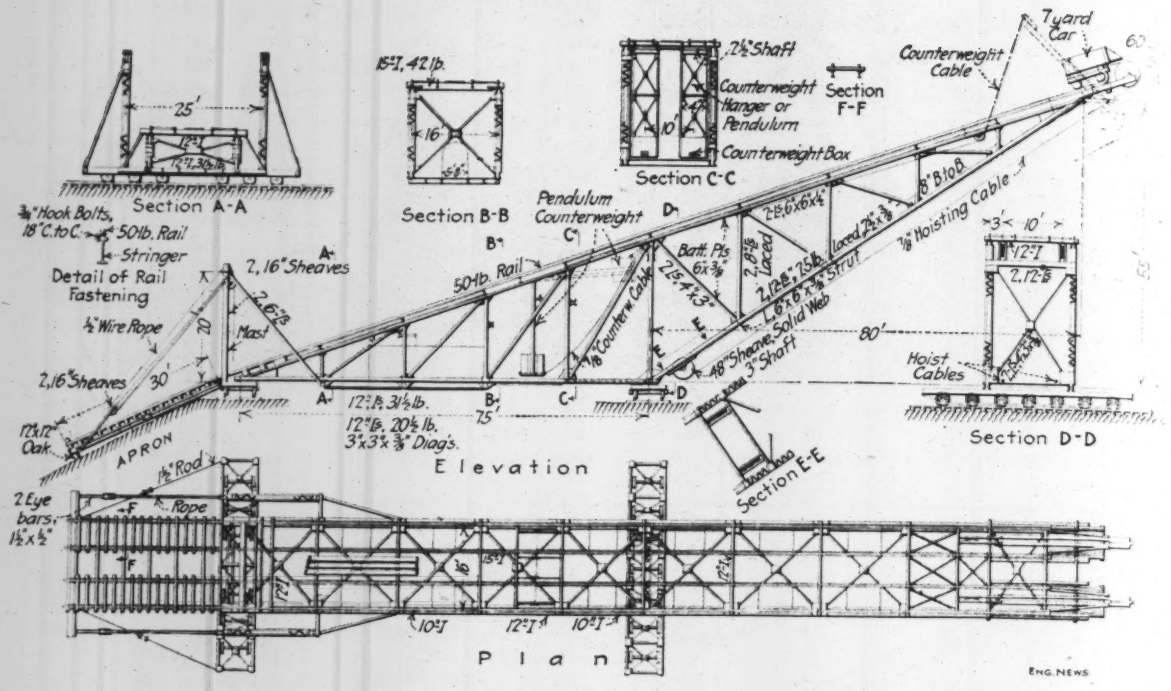


FIG. 2. DETAILS OF TRAVELING CANTILEVER DUMP OR TIPPLE, SHOWING THE DUMPING PLATFORM AND THE APRON EXTENDING INTO THE CANAL EXCAVATION

are 48 in. in diameter, placed tandem, and have band frictions and brakes. The friction bands are operated by steam rams. The speed of the hoisting cables is about 30 ft. per min. The engine is mounted on a separate car on the track nearest the slope of the cut. This is done in order to put the operator in a position where he has a full view of the cars throughout their entire travel.

The machine is used by the Byrne Bros. Dredging & Engineering Co., of Chicago, which has the contract for this section of the Sag Canal. It was designed by the Page Engineering Co., of Chicago. It is very similar to the machine used by Gahan & Byrne, contractors, on the main drainage canal (as already noted). The loads hoisted are greater, however, so that the present machine is somewhat heavier. It also has the new arrangement for raising the apron, as described above. It is too early to give any records of monthly output or daily average, as a good part of the work so far has been in starting the cut and getting the steam shovel down into the pit. However, the contractors state that 2000 yd. have been moved in a single shift, and that this is not its greatest capacity.

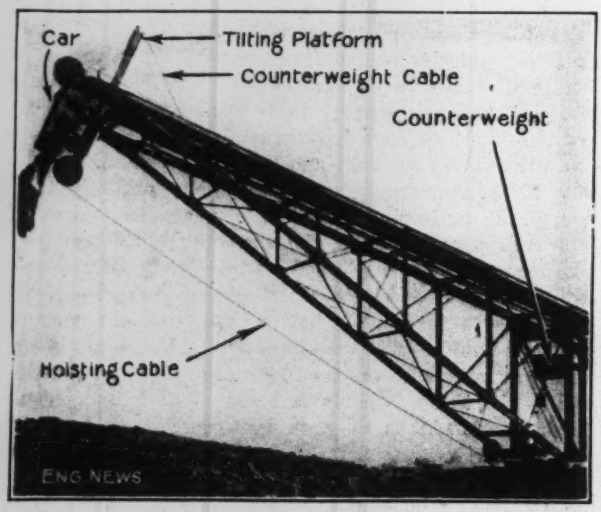


FIG. 3. CAR BEING DUMPED AT HEAD OF CANTILEVER TIPPLE

Calculating Earthwork Cross-Sections

WELLS' METHOD.—Various opinions have come to us regarding the method of calculating earthwork cross-sections given by L. W. Wells on p. 1303, of the issue of June 11. F. E. Foss, professor in charge of the department of civil engineering, Cooper Union, New York City, considers Mr. Wells' method "much more cumbersome than that based upon subdividing the area into triangles; which consists in multiplying the cut or fill by the difference in the distances out from the center." Another correspondent states that practically the same method is given in Nagle's "Field Manual for Railroad Engineers," pp. 189-190 (1897 ed.). Others have called our attention to the similarity of Mr. Wells' method to that given in our own columns in 1905, as noted in our issue of July 9, p. 86.

R. E. Gelder, of Greeley, Colo., writes that he has used the method given by Mr. Wells for years, and has calculated hundreds of miles of cross-sections for railroads, highways and ditches by it. He says:

I am acquainted with numerous other engineers who also favor and use it. On the other hand, I am acquainted with many who are strongly prejudiced against its use, principally for the reason that its proof is not obvious, and they have long used the easily proven trapezoidal method.

The method advocated by Mr. Wells, which the writer has always designated as the "triangular method," is quick, and is less tiresome, and, by reason of occasioning no mental subtraction and addition, less prone to error, than the trapezoidal method.

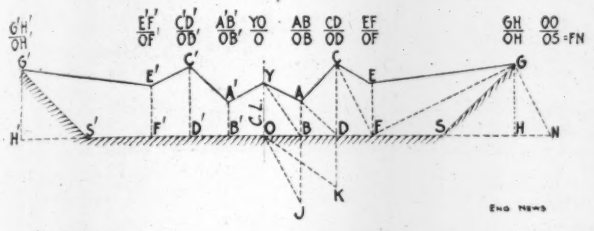
There are an infinite number of ways in which the truth of the method may be proved, but many would lead into a maze of calculations from which it would be nearly impossible to extract the relationship between the notes and the area.

The writer therefore believes that a study of the proof given herewith will convince many, not only of the truth of the method, but also of its simplicity; and prove that this triangular method is really a very close relation to the beloved trapezoidal method.

The accompanying figure represents a section in excavation in irregular ground, which for the sake of this analysis is made symmetrical about the center line. The left half is divided into trapezoids, and the right half for proof by the triangular method. Double areas are considered for the sake of convenience exactly as they are in the trapezoidal method.

Above the figure is a set of notes indicated by letters instead of numerals.

The manipulation of the notes has been fully explained by Mr. Wells and so will only be reviewed here in analysis.



ADDITIVE AREAS

Notes		Figures
YO × OB =	The double area of triangle YOB	
AB × OD =	" " " "	ABY and ABD
CD × OF =	" " " "	ACD, FCD, and OBJ in which BJ = CD
EF × OH =	" " " "	CEF, GEF, and ODK, in which DK = EF
GH × OS = GH × FN =	" " " "	GFN which equals GFS plus GSN

SUBTRACTIVE AREAS

OH × Zero = Zero		
GH × OF = GH × SN =	The double area of triangle	GSN
EF × OD = DK × OD =	" " " "	ODK
CD × OB = BJ × OB =	" " " "	OBJ
AB × Zero = Zero		

We have therefore deducted each of the external triangles and have remaining the area of the half section considered, (neglecting the operation of dividing by two) Q. E. D.

A brief examination of the left half of the figure discloses the reason for the external triangles in the analysis. Considering C'D' we observe that for double areas in the trapezoidal method it is multiplied by the distance to the intermediate on either side of B'D' and D'F', or all told, B'F', whereas in the triangular method CD is multiplied by OF, which is in excess of the amount B'F' by the amount OB, and we have, therefore, to exclude a triangle whose base is OB and whose altitude is the equivalent of CD, or the triangle OBJ, etc.

LOVELACE'S METHOD—O. G. Bunsen, of 1882 San Berbard St., Austin, Tex., writes that for the last 20 years he has used a method of calculating the end areas for earthwork formulas which is practically identical, but more concise, than that given by E. S. M. Lovelace in ENGINEERING NEWS, May 28, p. 1200; and he inherited it from engineers who came before. The difference is that the horizontal axis *OX*, or reference line, instead of being the H.I., as in Mr. Lovelace's method, is the grade level. The field notes are recorded to show the actual cuts and fills.

Referring to Mr. Lovelace's demonstration of notes taken from Sta. 41, and Fig. 3, p. 1201, the notes would read:

Sta.	Elev.	Grade		Left		C		Right		
41	97.40	91.50	0	+1.7	+3.8	+5.9	+7.2	+6.4	+6.9	0
			10	12.5	8.0	sta.41	6.0	13.0	20.4	1

By Mr. Bunsen's rule; $2A$ = algebraic sum of the products obtained by multiplying each distance out by the difference of the adjacent heights either side of the distance out, always taking the height between the center and the distance out as the minuend.

$$2A = 10(1.7 - 0) + 12.5(3.8 - 0) + 8.0(5.9 - 1.7) + 6.0(5.9 - 6.4) + 13.0(7.2 - 6.9) + 20.4(6.4 - 0) + 10(6.9 - 0) = 298.56.$$

$$A = 149.28.$$

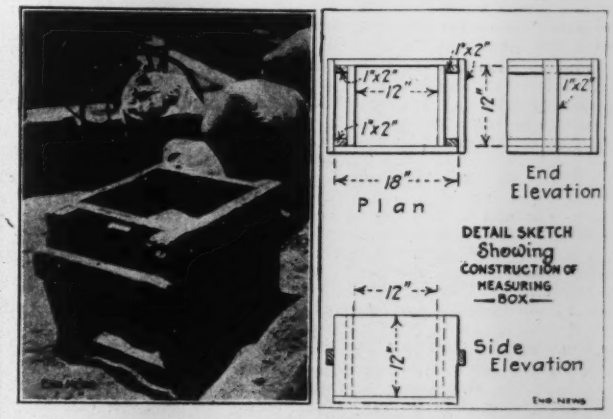
The value of this rule, Mr. Bunsen says, consists in that it is automatic, following a fixed routine, thereby avoiding the error of skipping some of the data. The rule is general and can be applied to any kind of a cross-section.

This method is similar to the one given by C. F. Koppisch in the issue of June 11, p. 1303, which is criticised by Mr. Lovelace as follows:

My method given in "Engineering News" of May 28, p. 1200, is a general one, independent of any particular method of keeping field notes. In the notes as given on p. 1201 the numerators are the actual rod readings and the denominators the actual distances out from center. While it may be a convenience in some cases to have notes recorded as showing the actual cuts and fills, so far as arriving at the area of the section is concerned, nothing at all is gained and time is lost in subtracting the rod readings from the grade-rod reading in the field and so recording them. The method under discussion is principally of use where the sections have numerous intermediate readings, and then any device that will save time either in the field or office is of value.

NOTES

A Good Detail for Measuring Boxes—Measuring concrete materials accurately is essential to good work. On one section of the Passaic Valley Sewer, the contractors, Frazer & Burchenal, are using a small rotary batch mixer and measuring sand and cement in home-made boxes which are built as shown in the accompanying sketch. These boxes are made throughout of 1-in. material; the end pieces afford not only a good tie, but a very good handle by which the boxes can be lifted.



A CUBIC-FOOT BOX USED TO MEASURE CONCRETE MATERIALS FOR A SMALL BATCH MIXER

Boston's Lone Skyscraper—The accompanying illustration shows the stage of construction on the tower surmounting the Boston, Mass., Custom House, on July 31. This building is about 325 ft. high, or about half the height of the Woolworth Building in New York City; yet it is Boston's single skyscraper, because Boston has an ordinance limiting the height of any building to 125 ft.—and the United States Government is the only landholder who can violate the law

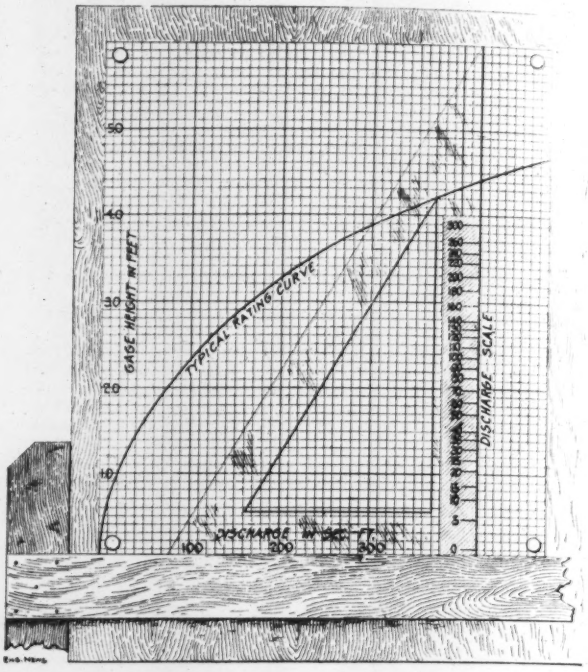
TOWER ON THE CUSTOM HOUSE, BOSTON, MASS., JULY 31

with impunity. When the city of Boston wanted to build its new office building some 130-odd ft. high, it had to go to the state legislature to get exemption from the general law, but Uncle Sam just builds and says nothing.

Plaster Statuary Is Being Placed on the Panama-Pacific Exposition buildings by a locomotive crane. Winged ladies, or angels, like those shown in the accompanying illustration, technically called the "acroteria" are placed on small pedestals at the peaks of the gables on several buildings. There are 32 such figures altogether, weighing about 1400 lb. each. The locomotive crane is operated on railway tracks reaching all the exhibition buildings. By means of a pole chained to the crane arm a sweep of 75 or 80 ft. is possible. The statuary is placed on flat-cars at the exposition studios and drawn directly to the building where it is to be placed. The placing is accomplished with one swing of the extended crane arm. The locomotive crane is only used in placing the statuary on the lower parapets; some of the statuary has to be placed at a height of 400 ft., which requires special hoisting tackle.

A Device for Computing Stream Flow—It is interesting to note that the device for recording heights from a recording tide-gage, described in our issue of June 25, p. 1430, can be modified for use in stream-gaging work. The usual method of obtaining the discharge of a stream from the record of daily gage heights is to take the mean of several heights for one day, and obtain the corresponding discharge from a rating table. The table is made up from a rating curve, drawn with discharge measurements of the stream plotted as abscissas, and corresponding gage heights as ordinates. Instead of using a rating table, a scale of discharges may be taken directly from the rating curve and pasted on the back of a transparent triangle, as shown in the accompanying sketch. This is used as is the device mentioned above, except that as it is passed over the gage sheet, discharges are read off instead of gage heights. A T-square fastened at the free end with a carriage-maker's clamp serves as a [illegible] on which to slide the triangle.

Frank Weber, of Owyhee, Nev., claims to have de[illegible]d this device for stream-gaging, while in the Albany office of the U. S. Geological Survey. He claims it to be especially useful in gaging streams which have wide daily fluctuations.



SET-UP FOR COMPUTING STREAM FLOW

PLACING STATUARY ON THE PANAMA-PACIFIC EXPOSITION BUILDINGS WITH A LOCOMOTIVE CRANE

Editorials

Immediate South American Needs

When the serious nature of the present European war was realized, the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce directed the various consuls in South America to report on the classes of goods most required in their localities now that European imports have ceased. These reports, which have just been circulated, have interest to manufacturers of engineering materials, and indirectly to those engineers who may contemplate entering the South American field, for if American material is to go south, American men will undoubtedly follow.

While a large part of the goods now required are outside of the engineering field the demand for cement and steel is widespread even thus early, which would indicate that construction work is either in progress or in prospect and that contractors supplies are going to be a need of the immediate future. The various cities and their specific engineering needs are as follows: Para—cement, manufactured iron; Rio de Janeiro—cement, steel wire; Montevideo—cement; Lima—cement, steel rails, tools, machinery, explosives; Bogota—machinery, railroad supplies, engines, cars, rails, bridges.

An Engineering Study of Smoke from Pittsburgh Boiler Plants

From time to time we have noted the smoke-prevention investigations in Pittsburgh regarding which, up to the present, only general information has been available. There now comes to hand a bulletin of the Mellon Institute of Industrial Research of the University of Pittsburgh, giving data on the operating conditions and smoke production of 147 stationary boiler plants (191 stacks) in Pittsburgh variously equipped with and without machine stokers. The general results of this survey are of wide interest, as comparing the relative smoke production of various systems of firing fuel under commercial operating conditions which are likely to be seen anywhere. Briefly reviewed, these data show that the 51 common hand-fired plant stacks, while under observation, produced no smoke 30 minutes out of an hour; 11 stacks from Dutch-oven furnaces were smokeless 34.5 minutes, the 36 chain-grate stoker plant stacks were smokeless 38 minutes, the 60 front-feed stokers 23 minutes, the 21 side-feed stokers 44 minutes, and the 12 under-feed stokers 43 minutes. The minutes per hour of producing 60% black smoke, or denser, for all these plants were: hand fired, 12; Dutch-oven, 5.2; chain grate, 2; front feed, 15; side feed, 2; and underfeed, 1. The average densities of smoke, compared with black, were: hand fired, 23%; Dutch oven, 13.6%; chain grate, 11%; front feed, 27%; side feed, 8%; and underfeed, 7%. The interesting point is the failure of front-feed stoker plants to work as well as the hand-fired boilers.

A New Danger for Bridges

By liberal use of scissors and paste on a recent issue of the Service Bulletin of the Iowa Highway Commission, we are enabled to present the following gem:

> Treacherous danger lurks in the old style bowstring type of iron bridge. There are thousands of them on main traveled roads in Iowa.
>
> You can see the danger in the rotten wooden bridge. The signs of decay are unmistakable. You cannot see the danger in the old crystalized iron. Your first intimation of danger in the age weakened structure comes with the sudden snapping of rods and beams and a crashing of wooden floor timbers. Between the two, the old bowstring is more treacherously dangerous than the rotten wood.
>
> There was little thought of danger on the Rutland bridge when a steam traction threshing outfit started across. Yet half a minute or so later the whole outfit lay at the bottom of the Des Moines River.
>
> There was no thought of danger when a similar outfit steered upon the Thornton bridge, yet only a projecting shelter formed by a self-feeder on the separator which striking the engine as the bridge went down kept a small space between the separator and the engine and saved the lives of the engineer and the steersman (sic).
>
> Every man who has crossed one has noticed the trembling of the structure and the rattle of the rods and members of the bridge. The metal in them has every inducement to crystalize.

We restrict the above quotations to the essentials. Were it not for this we would go on and relate, still quoting, how thousands of these bridges, freshly painted and good looking, are "waiting, veritable death traps set with the fickly hair trigger strength of crystalized metal."

In the past bridges have broken down because they were overloaded; that is to say, either loads were run upon them which were greater than they were designed for, or being perhaps poorly designed or built they were unable to carry the loads which the design supposed them good for. But now we learn that there is a third and more lurking danger—one that has a "fickly hair trigger strength."

In view of the great importance of this to bridge engineers and the vast public which occasionally uses bridges, we call upon the editors and backers of the Service Bulletin of the Iowa Highway Commission to present all obtainable and necessary facts on the new danger and to thus demonstrate it to the world in order that all may take proper steps for protection. Since the old superstitions about the so-called crystallization of structural metal have long ago been killed off, something new must have been discovered in Iowa. We call for the facts.

It may be, of course, that the real danger to bridges is not the "fickly hair trigger strength" above referred to, but the Iowa Highway Commission itself. If that be the case, the nation at large is not in as great danger as Iowa; at the same time the process of cure is simpler.

Why Not Preserve the Natural-Cement Industry?

A few years hence the engineer who happens to be engaged on a piece of work where he prefers, for certain reasons, to use natural cement, or, as it is perhaps most commonly termed, Rosendale cement, will find, we fear, that he cannot obtain it in the market. It seems to us that this would be a serious misfortune and that the engineers of the country will do well to consider whether they ought not to make a larger use of natural cement. For it rests absolutely with engineers whether this industry shall survive or whether it shall become one of the lost arts.

Most engineers of mature years know that up to about 15 years ago most of the cement used in the United States was natural cement and natural cement only. In 1890, for example, over 7,000,000 bbl. of natural cement were produced in the United States. In the same year only 335,000 bbl. of Portland cement were made in the United States and 1,940,000 bbl. were imported. Not till 1896 did the annual production of portland cement in the United States exceed a million barrels; and in that year nearly 8,000,000 bbl. of natural cement were produced. In 1900 the production of portland cement exceeded the production of natural cement for the first time. Since then the production of portland cement has increased by leaps and bounds, amounting to 92,027,000 bbl. last year. The natural-cement industry has declined meantime, falling below 1,000,000 bbl. for the first time in 1911.

It may be said that the reason for the decline of the natural-cement industry is a commercial one. Portland cement made by modern processes in huge plants is produced at so low a figure that the natural cement, produced on a comparatively small scale and by old-fashioned methods, could barely compete with it even if the two materials stood on an equal footing in the market. Of course, they do not stand on an equal footing. Portland cement is recognized as on the whole a superior material to natural cement; so the purchaser, or the builder, or the engineer says, "since the difference in cost is so little, let us specify the best material."

If this were indeed the whole story, then we might look upon the disappearance of the natural cement industry with equanimity. But is this the case? Some of the older engineers, thoroughly experienced in the use of natural cement, can testify to the excellence of this material when properly handled. It has moreover some characteristics which portland cement does not possess. It is for one thing slow setting, and slow setting by nature and not by reason of artificial additions to the mixture. In the second place it lends itself readily to a number of uses to which portland cement is not by any means as well adapted. It works under the trowel like lime mortar, with a smooth, buttery consistency that conduces to good workmanship. Portland-cement mortar, on the other hand, has little consistency and it is very difficult to give it exactly the right moisture to handle well with the trowel. A great deal of work has to be finished either too dry or too wet for the best results.

Again natural cement has a record of experience back of it that is possessed by very few works in portland cement. It is true a great deal of the old works in natural cement were laid with an admixture of lime mortar. There are, however, plenty of old structures standing in the State of New York and elsewhere, which were built in the days when natural cement was practically the only reliance of the engineer and whose condition today gives eloquent testimony to the excellence of that material. In contrast with this must be placed some of the experiences in recent years in connection with the disintegration of certain structures built with portland cement. The cause of this disintegration is still a matter of controversy among cement experts.

Of course, it is believed that the causes of this disintegration will in time be discovered and removed; and we are by no means suggesting that portland cement does not fully deserve its present high reputation. It does seem worth while, however, for engineers not to lose sight of the merits and excellence of natural cement for works to which it is adapted. As we pointed out in the beginning, the great trouble is that if they continue to neglect the use of natural cement they will soon be in a position where they cannot secure this valuable material no matter how much they may happen to want it.

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A Dangerous Attack upon Standard Time

Some of the older readers of ENGINEERING NEWS may remember the confusion that existed throughout the United States prior to 1883 with reference to time. Since the true astronomical time, measured by the movement of the sun, differs at every point on the earth's surface, every city and town, if it used the astronomical time for its own location, would have a time different from every other city not on the same meridian.

Up to the late '70's, nearly all the railways of the United States were comparatively small isolated lines. The general practice was for a railway to take the astronomical time of the city where its principal offices were located and use that time for all points along its line. Small towns and cities usually used the same time as the railway, but larger cities often used their own time for local purposes and it was common to hear "city time" and "railway time" referred to. Connecting railways at a junction point often used different times, so that in the same city three or more different times might be in use.

To the general public, this meant a vast amount of confusion and uncertainty. To the railways it meant, in addition, a very serious danger. There was always risk that some employee's watch would be by mistake set to some city time instead of railway time or that there would be confusion between the relative times of connecting railways.

When railway consolidation and expansion and the construction of the great transcontinental lines began, the absolute necessity for radical reform in the matter of time became evident. It was this, in fact, which first brought the railway companies together for general conference in an organization which was the predecessor of the present American Railway Association, and was for years known as the General Time Convention.

It is worth noting that the most influential figure in bringing about the adoption of the present system of standard time was an eminent civil engineer, Sir Sandford Fleming, of the Canadian Pacific Ry. Another who

deserves special credit for this great reform was also a well known civil engineer. Mr. W. F. Allen, who still continues his responsible work as General Secretary of the American Railway Association. The present system of standard time was the result of more than two years of thorough and careful study. It was adopted on Nov. 18, 1883, and for more than 30 years has continued in use. No one who realizes the chaos and confusion and danger that existed in connection with matters of time distribution previous to 1883 would dream of countenancing any movement that might cause a return to those conditions even in part.

On May 1, 1914, an ordinance became effective in the city of Cleveland which makes Eastern time, instead of Central time, the legal standard in that city. A traveler to Cleveland who sets his watch back an hour when he passes Buffalo, finds when he reaches Cleveland that he must set his watch an hour forward again to Eastern time. If this were all, it would be a local matter affecting Cleveland only; and so long as its citizens choose to put up with the annoyance and difficulties due to having local time one hour different from the time of the railways entering the city, it would be of little importance elsewhere. Cleveland, however, is bringing strong pressure to bear upon the railways entering the city to induce them also to change to Eastern time. Other Ohio cities seem to have a vague idea that there is something progressive involved in this change and are agitating for a similar action, and it is even proposed that the entire State of Ohio shall adopt Eastern time as its standard.

If this movement should be forced through—and there is danger that it may be, in view of the control over the railway companies now held by the State Railway Commissions—it will necessitate a complete revision of the points of change from Eastern to Central time all the way from the Canadian border to the Gulf of Mexico.

The executive committee of the American Railway Association has seen and realized the danger. In a report presented at the last meeting of the Association, the committee says:

> If the system of uniform standard time is to be changed in a way which may threaten its impairment or destruction, the final action taken should be at least as deliberate and unanimous as at the time of its adoption. Certainly individual railways or communities ought not to pursue a course which may be detrimental to other railways or to the public interest, without competent and careful consideration being given to the effect upon those interests.

It is difficult to see any justification whatever for Cleveland's action in changing its local time from Central to Eastern. If the motive in making the change was to give the city its true astronomical time instead of the standard railway time, then nothing has been gained. Cleveland is situated about midway between the meridians of 75° and 90° west of Greenwich, on which Eastern time and Central time, respectively, are correct. Thus, while the Central time is half an hour behind Cleveland's true astronomical time, Eastern time, which it has now adopted, is half an hour ahead.

We understand the argument brought forward in Cleveland is that in using Central time the day's work begins half an hour later than it should, and continues half an hour later in the evening. By the change to Eastern time, however, men now go to work half an hour earlier than Cleveland's true astronomical time, and quit half an hour earlier at night. If what the City wanted was to run on true astronomical time, then it should have adopted, not standard railway Eastern time, but a local time of its own, which, if made exactly half an hour different from the Central time, would have caused comparatively little confusion. If, however, the city wished to accomplish the thing it has now effected; to wit, to set the time of beginning and quitting work an hour ahead, it was not necessary to interfere with standard time at all, but simply order that factories and other places of work which now begin at seven o'clock, Eastern time, should start at six o'clock, Central time. The results obtained would have been absolutely identical with those that the present plan secures, and there would have been no upsetting of the system of railway standard time. It may be claimed that the unions and others would object to men being compelled to start work at six o'clock in the morning instead of seven, yet this is exactly what they are compelled to do by the change to Eastern time instead of Central time. Calling a horse by a different name does not change its color.

We hope the railway companies of Ohio, and the public authorities over them, will appreciate the dangers to the present satisfactory system of standard time which will result if railway-time standards in Ohio are changed to correspond to the whims of different localities. The matter of standard time is too serious and important, and is too far reaching in its effect to be a proper subject for municipal interference.

Letters to the Editor

Tidal Currents in the Cape Cod Canal

Sir—In your issue of Aug. 6, 1914, p. 324, you gave an interesting account of the opening of the Cape Cod Canal, and made reference to the operative problems that will be met in working a 100-ft. canal in a tidal current.

As you state in your article, the canal prism is not yet completed; for many reasons it was desired to commence operations before completion.

The canal is of special interest in connection with the study of hydraulics, inasmuch as it is perhaps the only waterway of comparatively uniform cross-section connecting open bodies of tide water with considerable difference in tidal elevations. It will provide a means of determining questions of flow of water through channels of large cross-section, which are hardly covered by the existing hydraulic formulas, necessarily based on canals of much smaller dimensions.

The tides in the two bays are substantially half tide apart; that is to say, when it is mean sea level on one end it will be high or low tide on the other, and the

maximum difference in both directions on mean tides is about 5 ft.

Until the canal is completed no final or accurate determinations of the velocity of the current are obtainable. Float measurements made through that portion of the canal where the depth is the minimum and where consequently the tidal current for the moment is at the maximum, show a current at the top of the tide for the average cross-section of the canal of 2.47 knots, and with a current very much less than this in those portions of the canal where it is full depth, or where the width is in excess of the 100 ft. This, of course, disposes of statements which have found their way in the press of currents greatly in excess of the above.

When the canal is completed it is my intention to make a complete analysis of tidal conditions and currents and publish the same in a paper.

From July 30 to Aug. 16, although limitations to a draft of 15 or 16 ft. were placed upon the boats that could be passed through the canal, 188 boats used the canal exclusive of the contractors' plant, of which 166 went through under their own power and 22 in tow.

There is no erosion, the water in the canal being perfectly clear.

WM. BARCLAY PARSONS,
Chief Engineer, Cape Cod Canal.

New York City, Aug. 19, 1914.

Another Proportional-Flow Weir; Sutro Weir

Sir—The article by Prof. E. W. Rettger, "A Proportional-Flow Weir," ENGINEERING NEWS, June 25, 1914, is of particular interest to the writer, and prompts him to call attention to a type of weir known as the Sutro weir, invented a number of years ago by the late Harry H. Sutro, and first applied to practical water measurement in October, 1908. A brief description and illustration of three of these weirs of one million gallons per day capacity each appears on p. 212 of the "Proceedings of the American Water Works Association," 1912, in a paper by E. H. Breidenbach, describing the water-softening plant at Owensboro, Ky.

Owing to the sudden death of Mr. Sutro before any permanent record had been made of the calculations involved in the evolution of the mathematical expression for the shape of the weir opening, the benefit of his analysis of the problem was almost wholly lost. A number of weirs had been constructed, however, and were in use, and a carefully conducted test on one of small capacity showed the discharge to be in direct proportion to the head within an extremely small percentage of error. It then fell to the writer's lot to analyze the problem anew and to derive the equation on which the shape of the curved side of the weir opening is based.

The Sutro weir differs from the shape suggested by Prof. Rettger only in two minor points. First, only one side of the opening is curved, the other being a straight vertical edge. Second, instead of employing the simple form in which the breadth of the opening approaches infinity as the head approaches zero, which shape, for obvious reasons, is undesirable practically, the base of the weir is limited to a convenient dimension and for a very small height the opening is rectangular. It has been found that for water the minimum height of this rectangle is about ⅛ in.; for smaller heights the coefficient of discharge becomes erratic.

Referring to Fig. 1, the weir opening is seen to be bounded by the vertical sides AG and BD (AG being made as small as practicable), the horizontal crest AB, and the curved portion DFH above the rectangle $ACDB$.

Let Q_1 be the discharge through the rectangle $ACDB$ due to the head h above the top of the rectangle. Then

$$Q_1 = \tfrac{2}{3} b \sqrt{2g}\,[(h+a)^{\frac{3}{2}} - h^{\frac{3}{2}}] \qquad (1)$$

where a is the height of the rectangle. Next, consider a thin strip EF of thickness dy and length x, situated a distance y above CD; dQ_2, the discharge through this strip due to the head $h - y$, will be

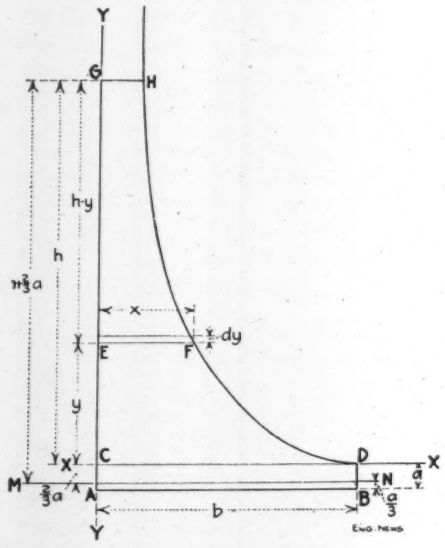
$$dQ_2 = \sqrt{2g}\,(h-y)\,x\,dy$$

The expression for the total discharge of the curved portion of the weir therefore is

$$Q_2 = \sqrt{2g}\int_o^h \sqrt{h-y}\,x\,dy \qquad (2)$$

If the total discharge of the weir be called Q, then

$$Q = Q_1 + Q_2 = \tfrac{2}{3} b \sqrt{2g}\,[(h+a)^{\frac{3}{2}} - h^{\frac{3}{2}}] + \sqrt{2g}\int_o^h \sqrt{h-y}\,x\,dy \qquad (3)$$



The object being to determine the shape of the weir such that the discharge is proportional to the head above a given datum line MN (Fig. 1), a second expression for the discharge Q is readily found. The datum line MN may be taken at any position between the base AB and the top CD of the rectangle. For convenience of calculation as well as of practical operation, *the line MN is taken a distance of one-third the depth of the rectangle* above AB.

This second expression for Q then becomes,

$$Q = K\,(h + \tfrac{2}{3} a) \qquad (4)$$

where K is a constant whose value is to be determined.

Since the proportionality must hold at all points above the top of the rectangle $ACDB$, eq. (4) must hold when $h = 0$, in other words, when the depth of water is just equal to the depth of the rectangle.

Substituting $h = o$ in eq. (3) and (4),

$$Q = \tfrac{2}{3} b \sqrt{2g} \times a^{\frac{3}{2}}, \text{ and } Q = \tfrac{2}{3} K a$$

whence

$$K = a^{\frac{1}{2}} b \sqrt{2g} \qquad (5)$$

Substituting the value of K in (4),

$$Q = \tfrac{2}{3} b \sqrt{2g} \left(\tfrac{3}{2} h a^{\frac{1}{2}} + a^{\frac{3}{2}}\right) \qquad (6)$$

$$Q = \tfrac{2}{3} b \sqrt{2g} \left(\tfrac{2}{3} h a^{\frac{1}{2}} + a^{\frac{3}{2}}\right)$$

Equating the right-hand members of (3) and (6),

$$\tfrac{2}{3} b \sqrt{2g} \left(\tfrac{3}{2} h a^{\frac{1}{2}} + a^{\frac{3}{2}}\right) = \tfrac{2}{3} b \sqrt{2g} \left[(h+a)^{\frac{3}{2}} - h^{\frac{3}{2}}\right] + \sqrt{2g} \int_o^h \sqrt{h-y} \, . \, x dy$$

Transposing and simplifying,

$$\int_o^h x \sqrt{h-y}\, dy = \tfrac{2}{3} b \left[a^{\frac{3}{2}} + \tfrac{3}{2} h a^{\frac{1}{2}} + h^{\frac{3}{2}} - (h+a)^{\frac{3}{2}}\right] \qquad (7)$$

Expanding $(a+h)^{\frac{3}{2}}$ by the binomial theorem,

$$\int_o^h x \sqrt{h-y}\, dy = \tfrac{2}{3} b \left[h^{\frac{3}{2}} - \tfrac{3}{8} a^{-\frac{1}{2}} h^2 + \tfrac{1}{16} a^{-\frac{3}{2}} h^3 - \tfrac{3}{128} a^{-\frac{5}{2}} h^4 + \tfrac{3}{256} a^{-\frac{7}{2}} h^5 - etc.\right] \qquad (8)$$

It is evident that $x\sqrt{h-y}$ is identical with, and may be replaced by, a series which, where integrated with respect to y and after substitution of the limits, will give a resultant series identical with the right-hand member of eq. (8). It is evident on inspection that this condition is fulfilled when,

$$x = A_1 + A_2 y^{\frac{1}{2}} + A_3 y^{\frac{2}{2}} + A_4 y^{\frac{3}{2}} + A_5 y^{\frac{4}{2}} + etc. \qquad (9)$$

where A_1, A_2, A_3, etc., are constant coefficients whose values are to be determined.

Inserting this expression for x in $\int_o^h x\sqrt{h-y}\, dy$,

$$\int_o^h x\sqrt{h-y}\, dy = A_1 \int_o^h \sqrt{h-y}\, dy + A_2 \int_o^h \sqrt{hy-y^2}\, dy + A_3 \int_o^h y\sqrt{hy-y^2} dy + etc. \qquad (10)$$

Integrating separately each term of eq. (10),

$$\int_o^h x\sqrt{h-y}\, dy = \tfrac{2}{3} A_1 h^{\frac{3}{2}} + \tfrac{1}{8}\pi A_2 h^2 + \tfrac{1}{16}\pi A_3 h^3 + \tfrac{5}{128}\pi A_4 h^4 + \tfrac{7}{256}\pi A_5 h^5 + etc. \qquad (11)$$

It is seen that the powers of h (the only variable) in the right-hand member of eq. (11) are identical with the powers of h in the right-hand member of eq. (8); also that each of these series is equal to $\int_o^h x\sqrt{h-y}\, dy$, which justifies the use of eq. (9).

Equating the right-hand members of (8) and (11),

$$\tfrac{2}{3} b \left[h^{\frac{3}{2}} - \tfrac{3}{8} a^{-\frac{1}{2}} h^2 + \tfrac{1}{16} a^{-\frac{3}{2}} h^3 - \tfrac{3}{128} a^{-\frac{5}{2}} h^4 + \tfrac{3}{256} a^{-\frac{7}{2}} h^5 - etc.\right] = \tfrac{2}{3} A_1 h^{\frac{3}{2}} + \tfrac{1}{8}\pi A_2 h^2 + \tfrac{1}{16}\pi A_3 h^3 + \tfrac{5}{128}\pi A_4 h^4 + \tfrac{7}{256}\pi A_5 h^5 + etc.$$

Equating the coefficients and solving for A_1, A_2, A_3, etc.,

$$A_1 = b;\ A_2 = -\frac{2}{\pi} a^{-\frac{1}{2}} b;\ A_3 = \frac{2}{3\pi} a^{-\frac{2}{2}} b;$$

$$A_4 = -\frac{2}{5\pi} a^{-\frac{3}{2}} b;\ A_5 = \frac{2}{7\pi} a^{-\frac{4}{2}} b;\ etc.$$

Substituting these values in (9),

$$x = b - \frac{2b}{\pi} a^{-\frac{1}{2}} y^{\frac{1}{2}} + \frac{2b}{3\pi} a^{-\frac{2}{2}} y^{\frac{2}{2}} - \frac{2b}{5\pi} a^{-\frac{3}{2}} y^{\frac{3}{2}} + \frac{2b}{7\pi} a^{-\frac{4}{2}} y^{\frac{4}{2}} - etc.$$

$$= b - \frac{2b}{\pi}\left[\frac{y^{\frac{1}{2}}}{a^{\frac{1}{2}}} - \tfrac{1}{3}\frac{y^{\frac{2}{2}}}{a^{\frac{2}{2}}} + \tfrac{1}{5}\frac{y^{\frac{3}{2}}}{a^{\frac{3}{2}}} - \tfrac{1}{7}\frac{y^{\frac{4}{2}}}{a^{\frac{4}{2}}} + etc.\right] \qquad (12)$$

But,

$$\sqrt{\frac{y}{a}} - \tfrac{1}{3}\left(\sqrt{\frac{y}{a}}\right)^3 + \tfrac{1}{5}\left(\sqrt{\frac{y}{a}}\right)^5 - \tfrac{1}{7}\left(\sqrt{\frac{y}{a}}\right)^7 + etc. = tan^{-1}\sqrt{\frac{y}{a}}$$

Therefore,

$$x = b\left(1 - \frac{2}{\pi} tan^{-1}\sqrt{\frac{y}{a}}\right) \qquad (13)$$

which is the equation of the curve DFH with respect to the axes XX and YY.

To determine the shape of a weir of specified capacity either a or b, and h may be made suitable dimensions, and b or a found by substituting the proper quantities in eq. (1), Q_1 being proportional to the ratio of $\frac{2}{3}\,a$ to $(h + \frac{2}{3}\,a)$.

The values of all constants being known, values of x corresponding to given values of y may be found from eq. (13).

The Sutro weir has been used on a number of water-purification plants, being particularly adaptable to the control of proportional chemical-feeding devices. The patent is owned by L. M. Booth Co., of New York, on whose water softeners the weir is also used.

E. A. Pratt,
Assistant Chief Engineer, N. Y. Continental Jewell Filtration Co.
New York City, July 7, 1914.

A Wonderful Pump

Sir—If by chance you think that there are no brilliant mechanical minds in the wild and wooly West, the following item from a local paper will refute such a view:

There is now being exhibited a new pump which the inventor, James Peterson, of Provo Bench, claims will revolutionize the pumping systems now in operation. This new invention is so constructed that the water in a great measure lifts itself. The pump is composed of two pipes or outlets, which act as a balance, and when in operation, the pumps will run with one-half the power that is necessary under the present systems in use. Demonstrations of the pump are now going on in different parts of the state. In speaking of his new invention, Mr. Peterson stated that his pump would lift 100 lb. of water with 50 lb. of energy, while with the pumping plants now in operation it takes 100 lb. of energy to lift 70 lb. of water. Mr. Peterson has also invented a new gasoline traction plow, which works on the principle of a spading fork.

If, as claimed, the pump will develop 200% efficiency, it is more than likely that it will indeed "revolutionize the pumping systems now in operation." Neither can the brilliancy be questioned of the idea of using water so that it, "in a great measure lifts itself."

L. M. H.

Provo, Utah, Aug. 14, 1914.

Gate Structures for Irrigation Canals—Concrete as a material for gate structures in American irrigation canals is beginning to displace wood, its durability overcoming the disadvantage of higher cost. Bulletin No. 115 of the U. S. Department of Agriculture purposes to submit to engineers such designs for gate structures for controlling the flow of water in ditches or canal systems as are adapted to different localities. Small and medium-size structures, for the most part, are described in the new bulletin. It does not attempt to exhaust the subject, but merely gives examples of structures which have satisfactorily served the purpose for which they were erected. As regards material the opinion of the investigator seems to be that a structure of combined wood and concrete, using the latter for inaccessible parts and wood for easily replaced parts, is the best practice.

Righting a Tilted Grain Elevator

SYNOPSIS—The Transcona grain elevator of the Canadian Pacific Ry. has a storage house about 200x75 ft., consisting of 65 bins 93 ft. high on a foundation slab, all of monolithic reinforced concrete. This structure, weighing some 20,000 tons, settled on one side till it stood at an angle of 27°, because of compression of soft strata. Concrete piers have been sunk to rock to form a secure foundation, and by excavating beneath the high side the structure is being righted so that it will come to rest on these piers, but at an elevation lower than its original level. Similar foundation piers have been put under the adjacent working house of the elevator, the foundation which did not settle.

The extraordinary case of the settlement and tilting of the storage-bin section of a large grain elevator near Winnipeg, until it stood at an angle of about 27° from

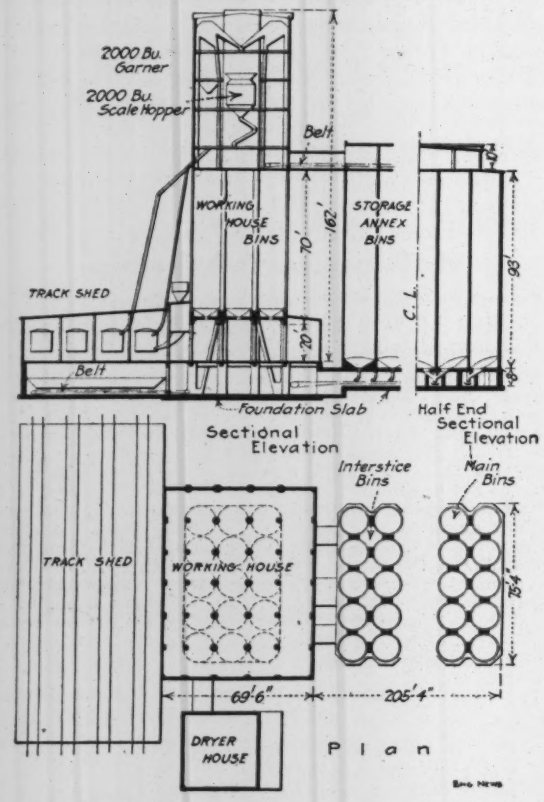


FIG. 1. GRAIN ELEVATOR OF THE CANADIAN PACIFIC RY., AT NORTH TRANSCONA; SHOWING THE ORIGINAL SLAB FOUNDATIONS

the vertical, was described in our issue of Nov. 6, 1913. We are now able to give some information as to the methods employed to check further movement, to restore the structure to a vertical position, and to place it on more stable foundations.

The grain elevator in question is that of the Canadian Pacific Ry., located at North Transcona, six miles east of Winnipeg. It consists of two units; the working house, containing the elevating, cleaning and other machinery; and the bin house of the annex, consisting of the storage bins proper. The latter is the part which gave trouble. The structure was built by the Barnett-McQueen Co., of Fort William, Ont., in 1912, and was put into service in September, 1913. The entire structure is built of reinforced concrete, with the exception of a few brick curtain walls in the working house. Its construction is shown in Fig. 1.

The working house is 44x90 ft. in plan, and is 162 ft. high from the base of rail to the roof. It is provided with a 16-ft. basement in which the belts for transferring the grain from cars to conveyor boots are located, together with belts for transferring the grain from the annex to the working house. The first section of 20 ft. above ground is occupied almost entirely by the cleaning machines. Above this point there are 15 bins 13 ft. diameter, 70 ft. high, surmounted by several floors containing the garners and weighing machines, together with the necessary machinery for loading grain into cars. The general design is shown in Fig. 1.

The bin house consists of 65 circular bins 14 ft. 4 in. diameter, and 48 diamond-shaped bins occupying the spaces between the circular bins. The bin bottoms were originally at about ground level. All bins are 93 ft. high, and are surmounted by a cupola 10 ft. high, making the original height of this structure from ground level to roof about 103 ft. The bin walls are of concrete 6 in. thick, reinforced for bursting pressures and for vertical loads. The storage capacity is 1,000,000 bushels.

As regards the foundations, each of these buildings originally rested on a reinforced-concrete mat, designed to spread the loads over the entire area occupied. The under size of the mat of the working house was at a depth of about 15 ft. below ground level, while that of the bin house was 10 ft. below ground level. These foundations were independent of each other.

Borings were taken immediately after the failure and the soil to be of a very treacherous nature, consisting of blue clay to a depth of 41 ft. below ground level. The upper 33 ft. of this clay was fairly stiff, but the lower 8 ft. was very soft and contained a great deal of water. Below this clay, from about 41 ft. to 50 ft. below ground level, was found gravel, together with a whitish clay which was very soft and contained a great deal of water. From 50 ft. to a depth of 55 ft. below ground level was found a layer of disintegrated limestone, and below this was bedrock.

These soil conditions appear to prevail over the entire district, and from work which has been done on the Red River at Winnipeg and on the same river at Kildonan it would appear that the bed of clay is very uniform in thickness. Load tests made before construction indicated that the soil could carry a load of 4 to 5 tons per sq.ft., while the actual load under the building was only about 2½ tons per sq.ft.

The elevator was first put into operation in the fall of 1913. In October, when the bin house is said to have contained 875,000 bushels of grain, a slight settlement was noticed but this was not of a serious nature. About Oct. 17, the settlement became very serious, and it is said that the building settled vertically a distance of nearly 4 ft., at which point it began to cant over in an easterly direction. This settlement continued for about

24 hr., until the whole building was leaning at an angle of about 27° from the vertical, and the westerly side of the foundation mat had sunk to an average depth of 29 ft. below its original elevation. At this point, movement ceased, the lower side of the mat having reached a stiffer stratum of the soil.

Fig. 2 shows the condition of the building after settlement, the conveyor cupola and roof structure having fallen off. At the right is the working house, with its track shed. Holes were cut in the bins and the grain removed, being delivered to cars by a temporary belt conveyor.

Strange to say, the working house was not seriously affected by the movement of the soil under the bin house. It suffered no damage beyond a few cracks in the walls adjacent to the annex, and there are no records which would show that any settlement took place in this building.

Soon after the failure, the Foundation Co., of Montreal, was called in to devise a scheme for underpinning the working house, the foundations for which it was feared might fail. That company was also asked to consider various means by which the bin house itself might be righted and restored to service.

After a number of conferences between the railway company's engineers and the officials of the Foundation Co., it was decided that the working house should be underpinned immediately by means of piers carried to bedrock. It was decided also that it was quite practicable to shift the bin house back into a vertical position, and when the actual moving was completed, to underpin it also by means of concrete piers carried to the rock.

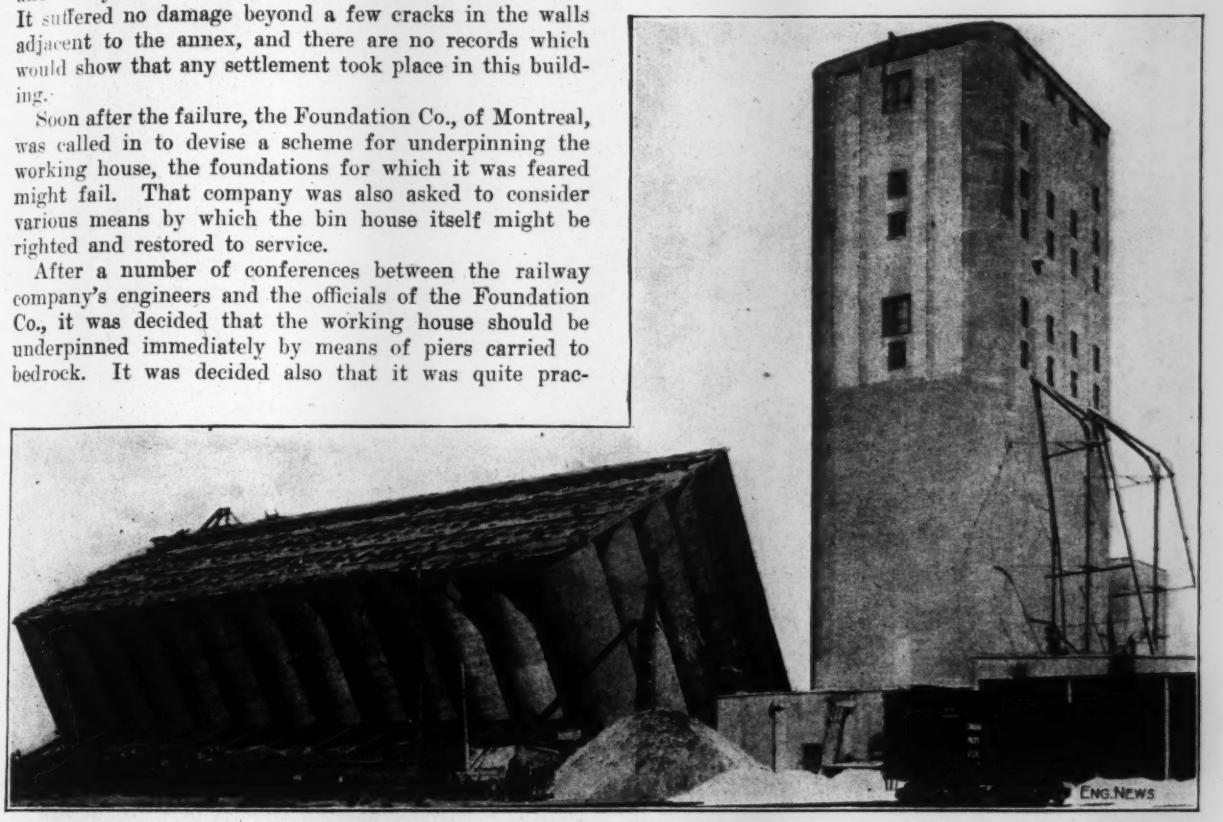


FIG. 2. THE STORAGE SECTION OR BIN HOUSE OF THE ELEVATOR IN ITS TILTED POSITION, WITH SHORING IN PLACE. AT THE RIGHT IS THE WORKING HOUSE

UNDERPINNING THE WORKING HOUSE

In January last, work was commenced on the underpinning of the working house. The scheme decided upon was to sink a pier under each column of the building. On account of the height of the building and the heavy column loads, it was necessary to shore the building completely before attempting to excavate under the columns themselves. In order to provide supports for the shoring, 16 small piers were sunk along the outside walls of the building, these piers being arranged to take the heels of the pusher timbers and to serve afterwards as supports for the outside walls.

At the westerly end of the building, four piers were sunk to rock in order to take the loads from the pushers at this point, these piers being located in such a position that they would serve as foundations for the columns of a possible future extension. A very complete system of heavy timber shoring was then installed, consisting of sets of 12x12-in. pushers heeling on the piers previously sunk and catching the heads of the columns immediately under the bin floors (Fig. 3). These timber pushers, together with the columns, the bin floors, and the foundation mat, formed a very effective truss system by which the load of the building could be transferred to the temporary piers.

Of the shoring piers above described, the first eight (located at the four corners of the building) were built by means of sectional cast-iron cylinders 4 ft. diameter, sunk to rock by excavating the material from the inside in the manner usually employed in sinking caissons. The shoring carried by these eight piers was then installed so as to give the building sufficient support to permit of the balance of the piers being put down as open wells with wooden sheeting held in place by interior iron rings, commonly known as the Chicago method. The piers inside the building were then commenced and were carried to rock by the Chicago method.

In order to get access to the under side of the columns for the purpose of sinking these piers, it was necessary to cut through the floor of the building adjacent to the column footings and to sink small shafts from which short tunnels were run to points directly underneath the columns. Fig. 3 shows the layout of the piers and the

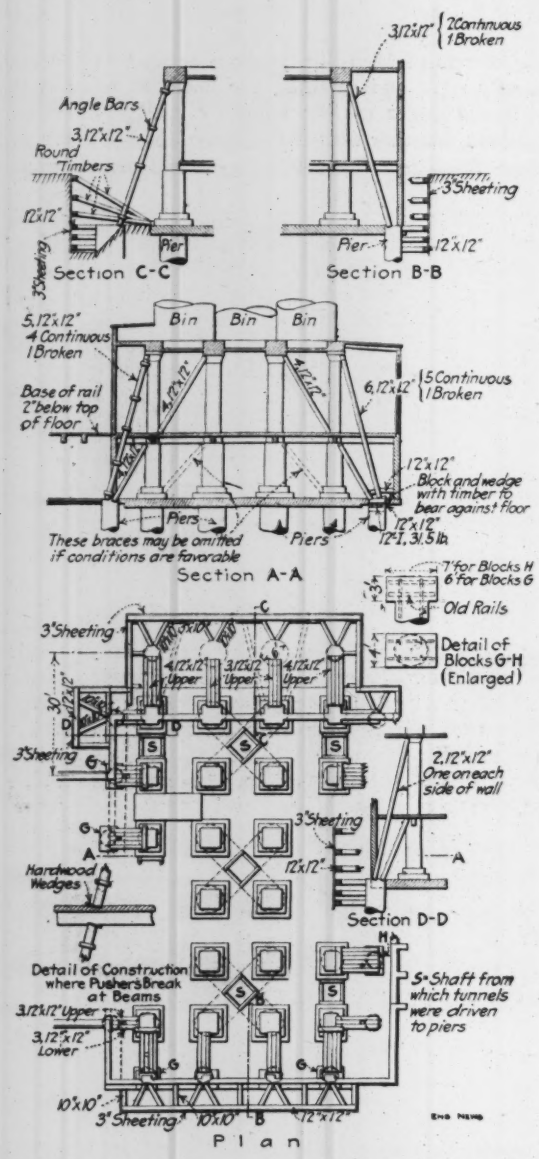


FIG. 3. UNDERPINNING THE FOUNDATION OF THE WORKING HOUSE WITH PIERS CARRIED TO ROCK

methods used in shoring the building, together with the location of the shafts and tunnels to the piers.

STRAIGHTENING THE BIN HOUSE OR ANNEX

Upon the completion of the underpinning of the working house, steps were taken to commence the work of straightening the bin house. In general, the scheme which is being adopted consists in righting the building by excavating the earth under the high side. It is expected that it will be quite practicable to bring the building back to a vertical position, although the structure will then be at a lower elevation than when first built. This fact, however, will not interfere with the operation of the elevator.

As stated above, it is the intention to provide new foundations for the bin house, these to consist of piers 7 ft. diameter, spaced approximately 15 ft. c. to c. and carried to rock. Fig. 4 shows the layout of these piers and shows also in general the position that the structure is expected to occupy after the completion of the turning movement. On all interior piers which are located under the "contacts" between the bins, the upper section of the pier is made 7 ft. square, so as to enable the loads to be properly transferred to the piers through the walls forming the passages underneath the bins. The exterior piers are provided with a corbel, heavily reinforced, so as to take the loads from the overhang of the bins, this corbel being extended about 4 ft. beyond the inner edge of the pier so as to minimize the effect of eccentric loads in the pier itself.

Fig. 5 shows the condition of the bins at the commencement of the turning operations, which were pro-

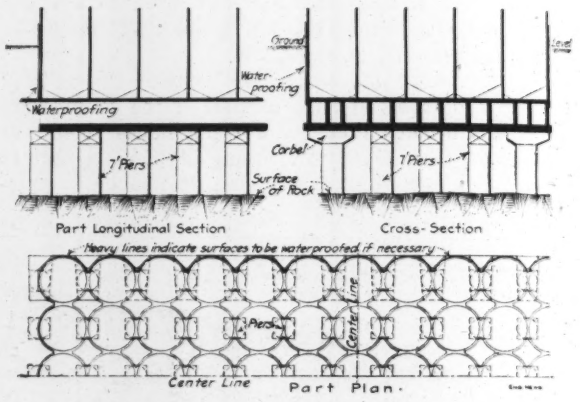


FIG. 4. THE NEW FOUNDATION OF THE BIN HOUSE, WITH PIERS CARRIED TO ROCK

ceeded with in the following manner: A trench was first excavated along the high side of the building and along the ends, this being stepped off at the natural slope of the soil, and being carried to a depth sufficient to enable excavation to be carried on underneath the mat. The surplus material from this excavation was handled by means of dump wagons.

Work was then commenced on the sinking of the line of piers along the low side of the building, it being the intention to block the building temporarily from these piers so that they would form a fulcrum about which the structure might be rotated some 15°.

Excavation was then commenced under the mat itself, being carried out in the form of drifts, driven transverse to the longitudinal axis of the building, leaving a triangular core of earth between adjacent drifts. It was the intention that as the mat was dropped this triangular core would offer increasing resistance to the movement and that the whole operation could be controlled by gradually cutting away the earth from the sides of this core. The surplus material from the excavation under the mat was removed by means of belt conveyors, one of which is clearly shown in Fig. 5. The condition of the building preparatory to making the first movement is shown at the left in Fig. 6.

While work was being done on the line of piers under the low side and while the drifts were being driven under the mat, work was rushed on all of the other piers, it being the intention to have the piers completed before the structure had moved through the first 15°.

These piers under the annex are being sunk by the Chicago method, that is, by sinking open wells, with wood sumps from which the water could be handled by centrifugal pumps, thus materially lowering the general ground-water level.

At the end of July, 85% of the piers had been sunk and concreted and the building had been rotated about the low line of piers at the rate of about 4 in. per day, the total drop at the high side of the mat being about 5 ft.

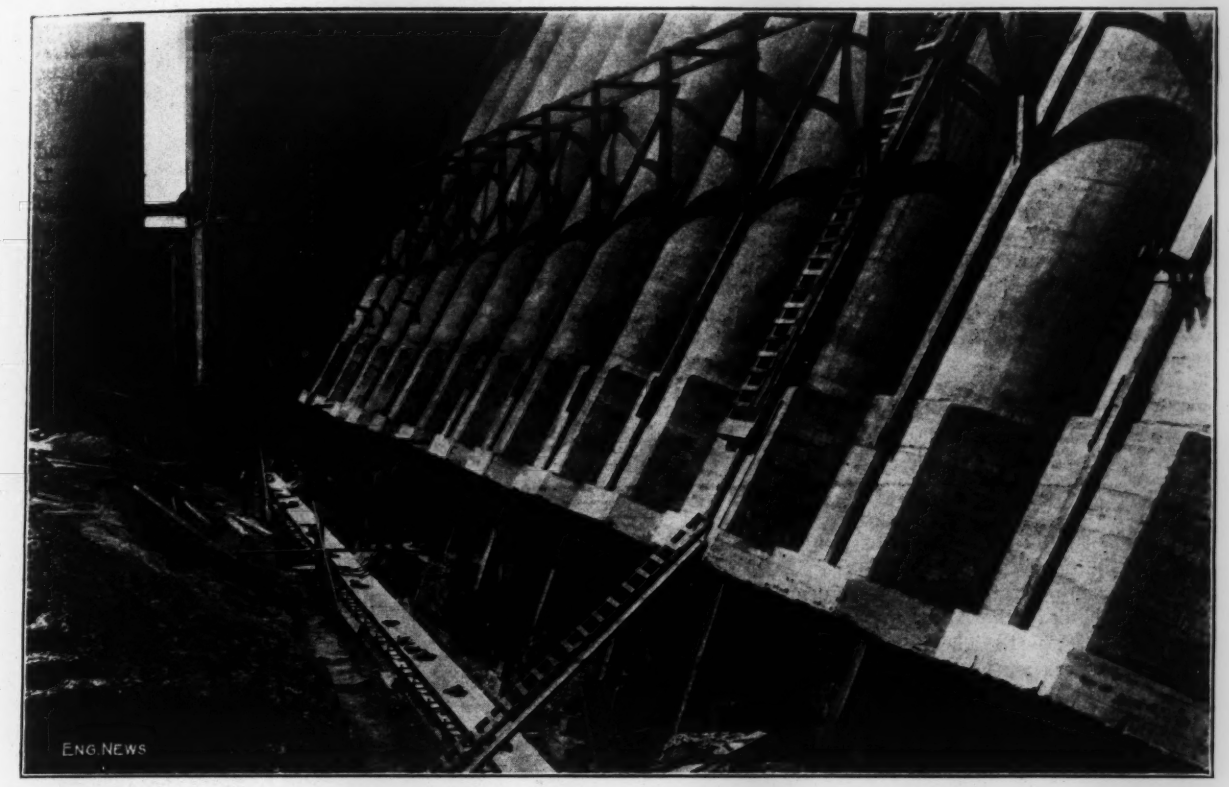


FIG. 5. PRELIMINARY EXCAVATION UNDER THE HIGH SIDE OF THE TILTED BIN HOUSE OF THE TRANSCONA ELEVATOR, CANADIAN PACIFIC RY.

lagging held in place by iron rings, which are removed as the pier is concreted. Considerable difficulty was experienced in the sinking operations on account of the large volume of water encountered in the gravel overlying the rock. This difficulty was more pronounced in the case of the first piers sunk, but the water was successfully controlled by using some of the piers as temporary

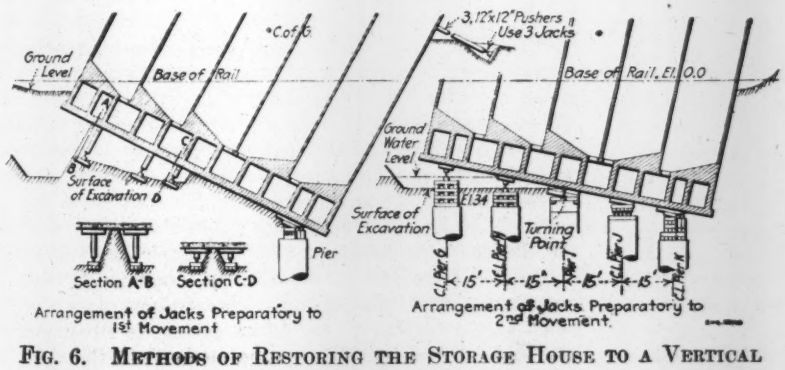


FIG. 6. METHODS OF RESTORING THE STORAGE HOUSE TO A VERTICAL POSITION (BUT AT A LOWER ELEVATION)

The movement of the building is being controlled by the earth cores assisted by shoring screws and short posts under the mat, as indicated at the left of Fig. 6.

As stated above, it is the intention to thus drop the building about the line of piers under the low side through 15°, which will bring the structure into the position shown at the right of Fig. 6. This being accomplished, it is anticipated that the balance of the turning movement can be made about the center line of piers, the load being controlled by means of groups of heavy jacks on the two lines of piers under the low side. This arrangement is shown clearly in Fig. 6.

During the progress of the work, it has been found that the movement of the structure can be controlled perfectly in the manner outlined above, and thus far the work has been entirely successful. Naturally in an undertaking of this kind, it is necessary to move carefully step by step, and in shifting a weight of some 20,000

tons it has been deemed advisable to move very slowly and to anticipate as for as possible all points at which trouble may develop. We are informed that it now seems assured that the building can be straightened, and that all operations can be carried out substantially as originally planned.

The underpinning and straightening operations are being carried out by the Foundation Co. (Limited), of Montreal and Vancouver, Canada, and we are indebted to that company for information and drawings. The work is under the direction of J. G. Sullivan, Chief Engineer of the Canadian Pacific Ry. (at Winnipeg); and Frank Lee, Principal Assistant Engineer, is in charge of the work for the railway company.

In this connection, we may refer to the similar settlement of a reinforced-concrete warehouse building in Tunis (Africa), which was righted somewhat in the same way as described above, assisted by loading the high side of the floors. In this case, the building when righted stood at an elevation 15 ft. below its original level. This work was described in ENGINEERING NEWS, Apr. 25, 1907.

An Air-Lift Pump with "Booster" for Horizontal Delivery

A water-supply independent of the city mains was desired by the Fort Pitt Brewing Co., of Sharpsburg, Penn., and to meet this requirement it was decided to sink wells along the bank of the Allegheny River. There are three wells, 150 ft. apart. The nearest is about 1350 ft. from the open cistern at the plant, and as the water was to be raised by the air-lift system some special means was required to force the water horizontally for this distance. For this service an air "booster" is employed. From the cistern a high-pressure pump delivers the water to an elevated tank.

The air-lift adopted is of the Sullivan type, in which a thorough mixture of the air and water is aimed at. This is considered to give less slippage of air and consequently higher efficiency, than the original Pohle plan of alternating "plugs" of air and water. The air (at 34 lb. pressure) is carried down outside the well casing in a 1-in. pipe, which at the bottom enters the elbow of the foot-piece or nozzle within the pipe. This nozzle, Fig. 2, is about 12 in. high, $1\frac{1}{16}$ in. inside diameter and it is pierced with rows of holes $\frac{3}{8}$ in. diameter, having an upward inclination of [illegible]. There are four holes in each [illegible]rcle.

This arrangement [illegible]ures a very thorough mixture of the air with the body of water. Above the nozzle the [illegible]in. delivery pipe is reduced to $2\frac{1}{2}$ in. diameter in order to increase the velocity, and above the foot-piece the diameter is increased to reduce the velocity at discharge.

The "booster" at the head of the well is shown in Fig. 1. It consists of a cast-iron chamber 30x30 in. with bottom connections to the well-delivery pipe and the discharge main. The delivery pipe extends up into the chamber and the stream of air and water discharged from it strikes a mushroom plate, which aids in the separation of air from the water. The end of the discharge main also extends up into the chamber and has its end slotted, while a drop pipe or sleeve over this end compels the water to pass upward before entering the pipe. A baffle-plate checks the splashing, and maintains comparatively still water around the discharge.

There is an open exhaust for the released air to escape to the atmosphere, but this is throttled by a valve so as to retain sufficient pressure above the water in the chamber to force it through the discharge pipe to the required distance. With the exhaust pipe full open it will discharge air and water, but the valve is closed until only air escapes. The operating pressure is 34 lb. at the receiver of the compressor, and the back pressure in the booster chamber is about 11 lb.

Each well has its own booster, and 4-in. discharge main, these three mains connecting with an 8-in. main to the cistern at the plant, where it discharges under water. The capacity of the cistern is about 18,600 gal.

Air is supplied by a straight-line compressor having a steam cylinder 12x12 in. and an air cylinder 14x12 in. This runs at 116 r.p.m., with a piston displacement of 248 cu.ft. of free air. The guaranteed capacity of pumping was 450 gal. per min., but the actual delivery (of the three wells) is 740 gal. per min. The theoretical horsepower is 10 hp., and with 26 i.hp. in the steam cylinder the efficiency (or relation of i.hp. to work done) is 40%.

The wells are 110 ft. deep, 10 in. diameter for 66 ft. and then 9 in. to the bottom. The strainer, which is located at the bottom of the 10-in. casing, is 10 in. diameter and 12 ft. long. The pumping head in the wells is 30 ft., and the elevation above the wells (including friction) is 25 ft., making a total lift or head of 55 ft. The

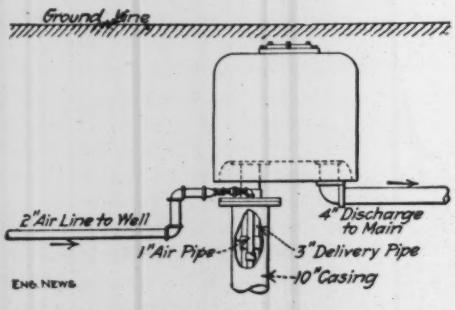


FIG. 1. BOOSTER AT HEAD OF AIR-LIFT WELL TO FORCE WATER THROUGH 1350 FT. OF HORIZONTAL PIPE

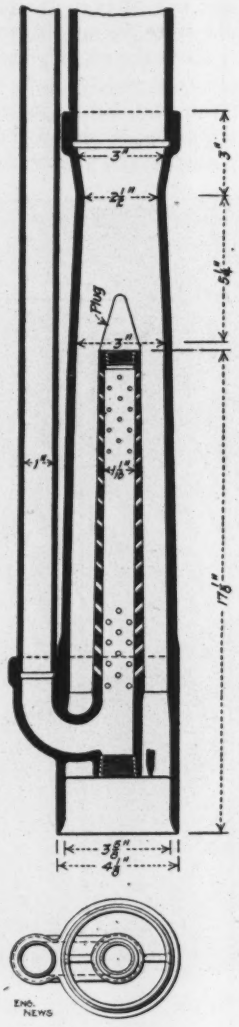


FIG. 2. SECTION OF FOOT-PIECE OF THE SULLIVAN AIR-LIFT PUMP

submergence of the foot-piece is 75 ft., or 58% of the depth.

Fig. 3 shows one of the boosters as installed temporarily with the air-exhaust pipe extending above it. When completed, each booster and its pipe will be inclosed in a concrete chamber beneath the ground, the exhaust pipe being bent to discharge downward within the chamber.

FIG. 3. BOOSTER CHAMBER ON AIR-LIFT WELL AT SHARPSBURG, PA.

The plant was designed by the Federal Engineering Co., of Pittsburgh, of which J. R. Kommer is President. The contract for the air-lift system and compressor was awarded to the Sullivan Machinery Co., of Chicago, and the details were worked out by John Oliphant, of that company, to whom we are indebted for plans and information.

Type of Boats for the New York State Barge Canal

The completion of the New York State Barge Canal is still some years away, but the prospective opening of certain branches is near enough to make necessary the consideration of the type of boat which will be best suited to the canal. A recent statement by the State Engineer and Surveyor, John A. Bensel, indicates that some difficulty is being met in planning the proper type of tow boats and barges. In the *Barge Canal Bulletin*, July, 1914, Mr. Bensel says:

A western manufacturing company, desirous of obtaining its raw material at a minimum of cost and of lessening freight charges on that portion of the finished product shipped east, recently made an investigation as to the comparative costs of rail- and water-borne transportation. The company found that it would not be desirable or economical to break bulk at any intermediate port and that the cargo vessel must be specially adapted, not only for safe carriage, but for cheap and rapid loading and unloading alongside warehouses or vessels.

The ship builders have found it impracticable to design a steamer that will satisfy the requirements of the Federal government for steam craft navigating the Great Lakes and also to keep within the limitations imposed by the Barge canal, such as restricted clearance of 15½ ft. under bridges and other fixed structures, at high navigable stage, the narrow width of 75 ft. in land sections and shallow depth of 12 ft.

The most promising solution of the problem for the company thus far devised is a fleet of two barges each 300 ft. in length and 40 to 43 in width, with an equal number of barges about 250 ft. long with 35 to 40 ft. beam, together with the requisite number of tugs about 50 ft. long, to tow one large and one small barge through the canals, and large sized lake tugs to tow a fleet of barges through the Great Lakes and rivers.

Boats having about 40 ft. beam cannot meet nor pass in the land sections of the canal where the bottom width is 75 ft. Numerous passing basins, where the canal prism is widened to at least 100 ft., will be necessary, if large sized boats are allowed to navigate the canals. Several such basins have already been constructed and there are also some natural formations of wide waters. Boats 300 ft. long can make all the curves in the canals, but as they will take up full width of channels while rounding the worst bends, they may have to slow down to a speed of about two miles an hour at those places.

It is likely that the largest number of vessels that will be built for canal use will be for fleet service and will be about 150 ft. long with a 22-ft. beam, that size permitting lockage of four at one time, one of the four being a power boat.

Another type of boat that will be used will be about 300 ft. long, the beam being from 40 to 43 ft. This type will probably be used for service on the Great Lakes. Undoubtedly most of the new boats will be of steel construction.

In vessels having a length of 300 ft., freight will be carried cheaper through the canal than in boats of smaller size. A single steamer could make better time through the new canal than a fleet of smaller boats.

Navigation of the land sections of the canal will probably be restricted to a maximum speed of about six miles an hour. The time for a single lockage will probably average 20 minutes.

A single steamer, while traffic is comparatively light, will make the run from Buffalo to Waterford in about 55 hours, but the average time will be about 72 hours for the 350 miles. In the Hudson River the time from Waterford to New York will be about 15 hours for the 150 miles.

Notes from Engineering Schools

A correspondence school for electric-railway men is being planned between the American Electric Railway Association and The International Correspondence Schools, Scranton, Penn. The courses will show general separation into mechanical- electrical- and civil-engineering branches—one being for young men in the shop, another for employees of the track and structures departments, and the third for those in power-house, substation and line work.

MUNICIPAL UNIVERSITY OF AKRON—A college of engineering has been established and five-year coöperative courses will be given. Applicants for entrance have been assigned to preliminary shopwork for this summer; regular instruction will begin in September. As usual, the students will be grouped in two sections alternating at work (commercial employment) and under instruction. Each school year will cover eleven months, one week vacation being allowed at Christmas and three weeks in late summer. Degrees of M. E. and C. E. will be given.

NEWS NOTES

A Tornado in the outskirts of Wilkes-Barre, Penn., on Aug. 20, killed five persons, injured many more, and wrecked about 20 houses. The damage was confined to an area four blocks square.

Gas Explosions in Three Manholes at the foot of Market St., Philadelphia, on Aug. 16, lifted the covers with such force that one was broken when it struck the under side of the elevated-railway structure.

Many Forest Fires are raging in Montana and northern Idaho. Press dispatches state that more than 2000 national-forest fires have occurred this season, of which 1000 have been in Montana and Idaho, 200 or more in California, and 350 in Oregon and Washington.

A Steamship Collision between the "Manna Hata" of the Baltimore Transportation Co., from New York to Baltimore, and the British steamer "Westland" from Antilla to New York, occurred about 17 miles above the Northeast End Lightship off the Delaware Breakwater, on Aug. 18. The bows of both vessels were damaged, but not seriously.

A Large Gasoline Tank Exploded in a garage in McConnellsville, Ohio, on Aug. 17, killing five persons and seriously injuring three others. The accident was caused by a spray of gasoline from the tank contacting with the hot engine of an automobile. All but one of the victims were in the garage at the time.

A Steel Lath-and-Plaster Ceiling Collapsed in the main operating room of the Keystone Telephone Co., Philadelphia, Penn., on Aug. 16, burying 15 telephone girls. Press dispatches state that firemen who examined the ceiling after its collapse stated that the plaster was spread too thickly over the laths, its weight pulling out the staples which supported the laths.

A Brick Foundation Wall Was Pushed in by earth pressure on the outside, at Allston, Mass., on Aug. 21, killing two men and severely injuring four others. The wall section which collapsed was about 50 ft. long by 10½ ft. high. A space 2 ft. wide between the wall and the sidewalk, and workmen were filling i nthis space with cellar dirt when the accident occurred. A block of one-story stores is being erected on the site.

Broken Sewer Floods Montreal Subway Undercrossing—A cave-in on Mill St., early on the morning of Aug. 16, broke the sewer from the Point St. Charles district, in Montreal, Que. The Wellington St. undercrossing (about ½ mile distant) was flooded as a result, and traffic was stopped there until 6 p.m. The street subsidence broke two 8-in. water mains as well; these were shut off within a couple of hours. A new sewer is being placed on Mill St. parallel to the old one and at the point of the collapse the trench was open to a depth of 15 ft.

Two Building Collapses—A wall section of a 40-year-old 4-story brick building in Brooklyn, N. Y., collapsed on Aug. 12. The wall section measured about 8x12 ft., and was between two windows on the second story near the chimney. It is probable that the heat from the chimney dried out the mortar, which was finally loosened by the vibration from frequent elevated trains which passed the building.

A theater under construction in South St. Paul, Minn., collapsed on the night of Aug. 4, under the weight of structural steel, which had been stored on the upper story. Press dispatches state that the weight of the steel was about 25 tons, and that it was hoisted on the afternoon of Aug. 4. The building was estimated to cost $35,000 when complete.

An Unexpected Loading of 1250 lb. per sq.ft. recently caused the collapse of a section of a timber wharf owned by the Canadian Northern Ry. at Port Arthur, Ont. The wharf in question is 400 ft. long and 74 ft. wide, and was founded on tamarac piles driven to rock at 5 ft. 4 in. centers each way, with 12x12-in. fir caps running transversely and with a 3-in. plank floor spiked to 6x10-in. joists. It was intended for a steel shipping pier but was designed for ordinary loadings, not exceeding 500 lb. per sq.ft. On July 4, 1914, in an effort to finish an unloading job, steel rails were piled on a part of the wharf to a height of 10 ft., the total loading being about 2129 tons and the maximum unit loading 1244 lb. per sq.ft. Soon after the unloading was finished a section about 80 ft. in length near the shore end of the wharf collapsed. No damage was done except to the wharf itself, and the rails, which fell in 20 ft. of water, have all been recovered.

Chinese Builders Win Hawaiian Contract—The War Department, Washington, D. C., awarded the contract for construction of part of the army hospital at Fort Shafter, Hawaiian Islands, to a Chinese firm, on July 20. This is said to be the first time on record that the U. S. Government has let such a contract to a foreign firm, especially to Chinese who are prohibited from competition with American labor in the United States. The Chinese firm was the lowest bidder for the hospital, at $119,000.

A Municipal Coal Mine—The City Council of Sydney, N. S. W., has adopted a report of the city electrician, according to "The Commonwealth Engineer," to acquire a coal mine, for the use of the department, within a radius of 70 miles by rail from Sydney, and a reasonable distance from the seaboard. During the year 1913, the city paid £28,341 for the coal used at powerhouses. It is estimated that this will increase to an annual charge of £50,000 in two years. It is stated that no proposition will be considered for a mine with less than 1,000,000 tons in reach.

The Bureau of Public Utilities Research, proposed by Director of Public Works, Morris L. Cooke, of Philadelphia, and Mayor Blankenburg, is receiving wide support. A convention to organize the movement, to which representatives of city governments throughout the United States will be invited to send delegates, will probably be held in Philadelphia Nov. 12 to 14 next. The Bureau will have as initial trustees: Louis D. Brandeis, lawyer, of Boston; C. R. Van Hise, President University of Wisconsin, Madison; S. S. Fels, manufacturer, Philadelphia; F. W. Taylor, consulting engineer, Philadelphia; F. A. Cleveland, Director Bureau of Municipal Research, New York City; L. S. Rowe, Professor of Political Science, University of Pennsylvania, Philadelphia; C. F. Jenkins, publisher, Philadelphia; Felix Frankfurter, Professor of Law, Harvard University, Cambridge. (See "Engineering News," July 2, 1914, for outline of aims of this bureau.)

The Concrete Eating Crawfish has now arrived to rival the oft-heralded steel worm that devours railway rails. The Kansas City, Mo., "Star," of Aug. 11, tells all about him in the following words:

A persistent crawfish found no difficulty in scooping out the supposedly solid concrete floor of a sewer built by W. C. Mullins, president of the Kansas City Concrete Pipe Company.

The picture [shown in the original; a pen-and-ink sketch of a sewer section some 3 ft. in diameter with a horrendous crawfish of chicken lobster size in the immediate foreground —Ed.] was introduced as evidence in the taking of depositions in the damage suit of the Kansas City Concrete Pipe Co. against "The Star."

The sewer was a 39-in. monolithic concrete sewer on Brookside Boulevard, south of Sixty-second St.

The "crawdad" had scooped out a large amount of gravel in its journey through the concrete wall.

A hole made by another one of the crawfish tribe is shown close by. Another "crawdad" was found in the same sewer a block and a half away under similar conditions.

It is to be hoped that the crusticeans do not travel in army-worm battalions.

Flood Protection Work at Lafayette, Ind., includes levees and bridge extension. The Brown St. bridge had two spans washed out by the flood of 1913, and these have been replaced by a single span. The Main St. bridge was so badly damaged that a new structure was required, which is now under construction and probably will be completed by the end of the year. This bridge consists of steel girders encased in concrete, replacing the old Whipple truss spans. It is of greater length in order to provide additional waterway, and its floor is 6½ ft. above the original elevation.

The levee on the west side, which leads up to the Main St. bridge and is about ½ mile long, is being raised 5 ft. and paved with wood block. The east approach will have a 5% grade to the new bridge level, and will be paved with brick. The water supply is obtained from a battery of wells near the river, with a pump house below the high-water level, but it is proposed to raise this to a higher level. The sewerage system was not damaged by the flood. H. B. Overesch, Jr., is City Civil Engineer.

The Rebuilding Commission at Salem—At Salem, Mass., a good work is going forward under the direction of an able Rebuilding Commission. In an armory centrally located an exhibition of fireproof building materials is being held, and every effort is being made to develop a better understanding of the essentials of fire resisting construction.

A great deal of space at the exposition is given over to educational work directed toward a more intelligent use of building sites. Many plans are exhibited to show the owner the best way he can use the typical 40x80-ft. lot in Salem; how he can join with his neighbors to so place their dwell-

ings as to get a maximum of light, air, yard, etc. The Commission is directing an able campaign against the notorious "three-decker," showing how better two-story dwellings affording more room than the "three-decker" can be built at comparative cost and in the same space. The exhibition includes drawings and photographs and perspectives of some of the best known recent work in housing development. The work of this Rebuilding Commission is of great interest, showing how the community spirit, awakened and well-directed, can make for better living.

The Later-River Drainage District of Missouri, comprising 127,500 acres, lying in Butler County, between the Black and St. Francis Rivers, has had plans for drainage and flood protection made for it by the Morgan Engineering Co., of Memphis, Tenn. The plans have been adopted by the Board of Supervisors of the District. A large percentage of the area outlined is subject to overflow from both of the rivers named. The works proposed include 58 mi. of levees, which would require 2,500,000 cu.yd. of earth. The levees would have a top width of 6 ft., side slopes of 2 to 1, and would average from 8 to 11 ft. in height. Dipper dredges could be used in the construction of the greater part of the levees, as also in the construction of a proposed system of ditches. The ditches would have bottom widths ranging from 12 to 55 ft., and depths of from 7 to 13 ft., and would aggregate 208 mi. in length. The ditch excavation would run up to some 8,000,000 cu.yd. of earth. For highway intersections 55 wooden bridges are proposed. The estimated cost of carrying out the project is about $1,250,000, or an average of $10.25 per acre of land benefited. The engineers named have completed the location survey for the ditches and leves, and asssors have been appointed for assessing the cost. As soon as the assessment roll is completed and confirmed by the court, which will probably be in about six months, it is expected that contracts will be let.

A New Passenger Station at Pocatello, Idaho, is to be built for the Oregon Short Line R.R., at a cost of $150,000 for the building and concourse and $175,000 for passenger yard trackage and other facilities. The station and tracks are at the street level. The building will be at the side of the tracks and 32 ft. from them, the intervening space being the concourse, which will be covered for a width of 22½ ft. The building will be 225 ft. long The central portion, 90x77 ft., three stories high, will have on the first floor the main waiting room (86x40 ft.) with ticket office, baggage checking counter, etc. The wings are 68x60 ft., two stories high, one containing the baggage and express rooms and the other containing the dining and lunch rooms. The upper floors will be occupied by the railway offices. There will be a hot-water heating system.

The building will be of fireproof construction throughout. The exterior will be of grey stone for the first story, and the upper stories will be of dark red brick, laid in ornamental pattern, with cut stone trim. The roof will be of asbestos shingles. The building was designed under the direction of E. E. Adams, Consulting Engineer of the Union Pacific System, and the construction work (which will be started at once) will be under the charge of Carl Stradley, Chief Engineer of the Oregon Short Line R.R. The architects were Carrere & Hastings, of New York, and the contract has been let to the Lynch-Cannon Engineering Co., of Salt Lake City, Utah.

The Need of an Investigation of an Additional Water-Supply for Philadelphia has been questioned by John C. Trautwine, Jr., formerly Chief of the Bureau of Water, in an open letter to Morris L. Cooke, Director of Public Works. Mr. Cooke some time ago asked the city council of Philadelphia for $15,000 to study the water-supply problem of Philadelphia, with special reference to an additional supply, including possible recourse to other sources than the present Delaware and Schuylkill River intakes within the city limits. Mr. Trautwine, in his open letter to Mr. Cooke, says:

(1) The works are now pumping, filtering and distributing at least twice as much water as the people can use and enjoy, and at least half of that water is thrown away, unused, by about one-fifth of the population, who thus victimize the other four-fifths.

(2) The waste could be stopped, the supply thereby rendered abundant, the use of water by the people increased, the quality rendered ideal, the cost diminished, and the present works relieved from overstrain, for a fraction of the amount which it is now proposed to expend immediately for works which would not then be needed. This would postpone, perhaps for twenty years, all necessity for enlarging the works.

(3) The water, brought to the city's present intakes by the Delaware and Schuylkill rivers, is absurdly ample for a dozen cities like Philadelphia.

(4) Therefore it is not necessary to seek other sources of supply; and no commission of experts is necessary to find out what is the matter with the city's water-supply.

In support of his contention, Mr. Trautwine quotes as follows from Director Cooke's reports for the years 1911 and 1912:

"We are undoubtedly fortunate in lying at the junction of two such magnificent waterways as the Delaware and Schuylkill. But it is not wise to allow this good fortune to be given as an excuse for a profligate waste of water—a waste certainly amounting to one-half of all we use.

From a study of the results obtained from other cities, there is hardly a doubt that, if meters were placed on those properties wherein waste is detected, the consumption would be so reduced that a good supply could be maintained in all sections of the city.

PERSONALS

Mr. F. D. Nauman has been appointed Division Engineer of the Baltimore & Ohio R.R. at Garrett, Ind., succeeding Mr. John Tordella, promoted.

Mr. E. N. Sheffield, Assoc. M. Am. Soc. C. E., recently Civil Engineer in the Land Department of the Central R.R. of New Jersey, has opened an office for the general practice of civil engineering and surveying at Nashua, N. H.

Mr. Dan C. Miller has resigned as Instructor in civil engineering at the University of Michigan, to become Assistant Professor of civil engineering at the Agricultural and Mechanical College of Texas, College Station, Tex.

Mr. Leonard S. Doten, M. Am. Soc. C. E., formerly Civil Engineer in the office of the Quartermaster-General, U. S. Army, has been appointed Hydraulic and Sanitary Engineer in the same office, a new position recently created by Congress.

Mr. D. W. Gross, Assoc. M. Am. Soc. C. E., Engineer of Construction and Chairman of the Valuation Committee of the Atlantic Coast Line R.R., has been appointed Valuation Engineer and has been relieved of all duties as Engineer of Construction.

Mr. Walter F. Beyer, former Assistant Engineer in charge of the Division of Lighthouses, Panama Canal, has resigned from the canal service. Mr. Beyer went to the Isthmus in February, 1911, and had charge of the project of lighting and buoying the canal. Previous to going to Panama, Mr. Beyer was for many years connected with the United States Bureau of Lighthouses.

Mr. Arthur N. Winslow, recently Chief Draftsman of the Eastern Bridge & Structural Co., Worcester, Mass., has been appointed Professor of structural engineering at the University of Idaho, succeeding Mr. D. B. Steinman, Jun. Am. Soc. C. E., resigned, as noted in our issue of last week. Mr. Winslow is a civil engineering graduate of the Massachusetts Institute of Technology.

Dr. Karl Imhoff, Consulting Engineer, of Essen, Germany, will probably not be able to make his trip to the United States in September, as he had planned. It is stated by Mr. S. Fischer Miller, President of the Pacific Flush Tank Co., United States and Canadian representatives of Dr. Imhoff, that all communications addressed to Dr. Imhoff in their care will be forwarded as soon as relief from present difficulties in Europe will permit.

Mr. Harry C. D. Nutting, recently Assistant to the President of the Wisconsin Public Service Co. and the Wisconsin Ry., Light & Power Co., Milwaukee, Wis., has opened an office in the First National Bank Bldg., Milwaukee, as Public Utility Expert and Engineer. Mr. Nutting is a graduate in engineering of the University of Illinois and was formerly an Engineer with the Wisconsin Railroad Commission and Electrical Engineer at the U. S. Government Arsenal, Rock Island, Ill.

Mr. W. R. McCann, M. Am. Inst. E. E., Supervisor in the former Division of Erection, Panama Canal, has resigned and returned to the United States. Mr. McCann joined the canal staff in 1907 in the department of lock and dam construction. He resigned in 1908 to take a special two-year course in engineering at the University of Wisconsin, and he was reappointed to the canal service in 1910, as Assistant Engineer, First Division. Under the Electrical and Mechanical Engineer, Edward Schildhauer, M. Am. Soc. C. E., Mr. McCann designed the entire electric transmission system of the Panama Canal, and as Supervisor, has had charge of the installation. Before going to the Isthmus in 1907, he was for three years with the Chicago Edison Co.

OBITUARY

John Cortelyou Bergen, a retired Mechanical Engineer, died Aug. 18, at his home in Brooklyn, N. Y., aged 56 years.

Thomas G. Carlin, a contractor, of Brooklyn, N. Y., died Aug. 21 at his home in that city. He was born in Brooklyn, Nov. 27, 1859, and was a brother of P. J. Carlin, Superintendent of Buildings of the Borough of Brooklyn.

Isaac Duell Barton, a former railway official, died Aug. 21, at his home in Flushing, N. Y., aged 80 years. He was at different time Assistant Superintendent of the New York & Harlem R.R., General Superintendent of the Long Island R.R., and General Superintendent of the Brooklyn Elevated Ry.

Henry K. Rowell, M. Am. Soc. M. E., Industrial Engineer, Principal Assistant in charge of the organization department of Charles T. Main, M. Am. Soc. M. E., Mill Engineer and Architect, Boston, Mass., died at his home in Boston, Mass., Aug. 9. He was born June 1, 1870, in Charlestown, Mass. His experience in mill work was extensive. He was engaged for several years in organization work in textile mills; for some time he was with Edward A. Buss, Consulting Engineer, of Boston, Mass., with Lockwood, Green & Co., also of Boston, and for the past eight years had been associated with Charles T. Main.

Darius Miller, President of the Chicago, Burlington & Quincy R.R., died Aug. 23, at Glacier Park, Mont., following an operation for appendicitis. He was born at Princeton, Ill., Apr. 3, 1859. At 19 years of age he entered the employ of the Michigan Central R.R., as a stenographer in the general freight office. Later he served in various clerical capacities with the St. Louis, Iron Mountain & Southern Ry., the Memphis & Little Rock R.R. and the St. Louis, Arkansas & Texas Ry. He was Traffic Manager and later Vice-President of the Missouri, Kansas & Texas Ry., Vice-President of the Great Northern Ry., and Vice-President and President of the Chicago, Burlington & Quincy R.R.

Henry L. Oestreich, M. Am. Soc. C. E., Senior Division Engineer, Public Service Commission, First District, New York, whose death was noted in our issue of last week, was born in New York City, Feb. 13, 1870. After graduating from New York University in 1888, he entered the office of Charles B. Brush, Consulting Engineer, Jersey City, N. J., where he remained until 1897, during which period he had charge of much important work. From 1897 to 1900, he was with the Bureau of Highways of the Borough of the Bronx, New York City, as Assistant Engineer. Mr. Oestreich entered the service of the old Rapid Transit Commission in 1900, and his subsequent work was given in the obituary notice of last week. [From Robert Ridgway, Engineer of Subway Construction, Public Service Commission.]

John N. McClintock, for many years a civil engineer of Boston, Mass., died, Aug. 13, at his home in Dorchester. He was born in Hallowell, Maine, 68 years ago, and was the son of a sea captain. He was a brother of William E. McClintock, M. Am. Soc. C. E., former Chairman of the Massachusetts Highway Commission, and James Y. McClintock, M. Am. Soc. C. E., County Engineer of Monroe Co., Rochester, N. Y. He graduated from Bowdoin College in 1867, and for several years was an officer in the United States Coast and Geodetic Survey. Later he practiced civil engineering in Boston, and was President of the American Sewage Disposal Co. and the American Water Purification Co. He was the author of a "History of New Hampshire" and many magazine articles, and was at one time editor of the "New Hampshire Magazine." He is survived by a widow and a son, John Cook McClintock, a Boston architect.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Sept. 1-4. Annual convention in New York City. Secy., J. D. Farasey, E. 37th St., and Erie Ry., Cleveland, Ohio.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 7-10. Annual meeting in New York City. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 7-11. Annual meeting at Chicago, Ill. Secy., A. P. Backert, Cleveland, Ohio.

NATIONAL PAVING BRICK MANUFACTURERS' ASSOCIATION.
Sept. 9-11. Annual convention at Buffalo, N. Y. Secy., Will P. Blair, 832 B. of L. E. building, Cleveland, Ohio.

NATIONAL ASSOCIATION OF PORT AUTHORITIES.
Sept. 8-10. Annual convention in Baltimore, Md. Secy., Wm. Joshua Barney, 29 Broadway, New York City.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 8-11. Annual meeting at Chicago, Ill. Secy., C. Ryan, Sterling, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 8-11. Annual convention in Nashville, Tenn. Secy., A. P. Dane, Reading, Mass.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 9-11. Annual convention in Boston, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 15-18. Convention in Atlantic City, N. J. Secy., Clayton W. Pike, Electrical Bureau, Philadelphia, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 21-25. Annual convention in Cleveland, Ohio. Secy., Joseph D. Israel, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Sept. 22-24. Annual convention in Bluff Point, N. Y. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn

ATLANTIC DEEPER WATERWAYS ASSOCIATION.
Sept. 22-26. Annual convention at New York. Secy., Addison Burke, Philadelphia, Penn.

INTERNATIONAL IRRIGATION CONGRESS.
Oct. 5-9. At Calgary, Alta. Secy., Andrew Miller, Industrial Commissioner, Calgary.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

NATIONAL COUNCIL FOR INDUSTRIAL SAFETY.
Oct. 13-15. Annual "Safety Congress," at Chicago, Ill. Secy., W. H. Cameron, Continental Bank Building, Chicago.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20. Convention at Los Angeles, Calif. Secy., C. A. Lichty, 319 North Waller Ave., Chicago, Ill.

Roadmasters and Maintenance-of-Way Association—The 32d annual meeting will be held Sept. 8-11, at the Auditorium Hotel, Chicago. Besides the various committee reports, there are to be addresses by a number of railway engineers and officials, and an extensive exhibit of railway materials and appliances will be arranged in one of the large halls of the hotel. The president is T. F. Donahoe, B. & O. R.R.; secretary, L. C Ryan, C. & N. W. Ry., Sterling, Ill.

New England Water-Works Association—The Committee of Arrangements has endeavored to make the 33d annual convention, to be held in Boston, Mass., Sept. 9-11, at the Copley-Plaza Hotel, of particular value to water-works superintendents, and to that end "superintendents' sessions" will be held on the afternoon of Sept. 10 and the morning of the 11th. Included in the rest of the program are the following papers: "Construction of Dams," A. E. Walden, Baltimore County Water &Electric Co.; "Electrolysis," E. B. Rosa, Bureau of Standards; "Allowable Leakage from Water Mains," E. G. Bradbury, Columbus, Ohio; "Lessons from the Salem Fire," Frank A. McInnes, Boston, Mass. Demonstration of water-main cleaning will be given. Liberal entertainment will be provided, with especial regard for the ladies. The secretary is Willard Kent, Narragansett Pier, R. I.

American Chemical Society—The convention scheduled to be held this fall in Montreal, Que., was canceled on Aug. 15 on account of the war between Great Britain and Germany. The following is quoted from a telegram sent C. L. Parsons, Secretary of the Society, by Prof. R. F. Ruttan, Chairman of the Montreal Committee of Arrangements.

The harbor, canals, etc., are under martial law. The excursions were off, as the steamboat company canceled our contract, for steamers for the rapids and harbor.

No German member of the Society would naturally come to British soil and all with German names would be questioned at the boundary. Many are even now turned back. We felt that the exclusion of so many prominent members of the Society was a high price to pay for a meeting here.

Any foreigners would be subjected to disagreeable formalities and conditions on coming here just now.

It would be impossible to attract to the Convention the slightest public interest in Montreal, outside a few dozen chemists. No one would come to the Conversazione or the garden parties we had arranged, and while there would surely be the feeling of good fellowship among ourselves, it would be overshadowed by the tragic war we are in at present.

Mr. Parsons states that "the present outlook is that the next meeting will be in New Orleans, Apr. 1-3, 1915. The office of the Secretary is in Washington, D. C.